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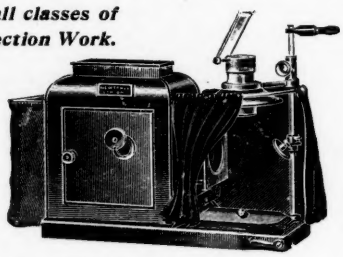

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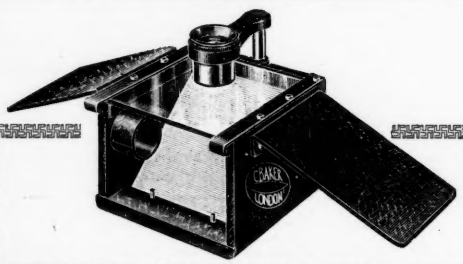

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For continuation of Official Advertisements see p. ii of Supplement.

SATURDAY, SEPTEMBER 14, 1929.

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What is Life?

AT the recent South Africa meeting of the British Association there was a conference on the nature of life, at which distinguished thinkers made interesting contributions, already referred to in our columns. It may be useful to try to gather the various suggestions into a connected whole.

(1) Modern discussions of this perennial question, What is Life? have shown in varying degrees a recognition of the commonplace that an answer lies in a fuller knowledge of living creatures. No amount of verbal dexterity or even profound reflection over the concept of 'life' floating in detachment will get us much 'forrarder' unless we are at the same time deepening our acquaintance with organisms from microbes to men, and trying to see life whole, not as a biochemical witch-pot merely, but as the activity of individualities that develop, grow, and reproduce, that struggle, vary, and evolve. If we are to answer the question, What is Man? or What is Personality? we must deepen our knowledge of men and of personalities, and of Shakespeare and Newton as well as of Bushmen. So to avoid false simplicity in our answer to the question, What is Life? we must seek a comprehensive, all-round, and intimate view of organisms, taking account of intelligent apes as well as of dimly purposive amœbæ, and of psycho-biosis as well as of bio-psychosis. We cannot make sense of any kind of life without recognising the importance of fermentation, but we cannot make sense of the life of higher animals apart from feeling, intelligence, and some sort of purpose; and the continuity of organisms makes it probable that the dim analogues of these psychical qualities are present throughout.

The extreme behaviourists or bio-mechanists, perhaps represented at the conference, to judge from the reports, by Prof. L. T. Hogben, will of course refuse to take account of any process which does not admit of physico-chemical analysis and description—a position that does not work out well in our daily life and conversation, where we have to allow at every turn for intelligent or even rational purpose—but even these extremists will agree that an understanding of life is most likely to follow a widening of our study of actual organisms.

(2) No one has as yet succeeded in re-describing in terms of anything else a fair and intact sample of that distinctive kind of activity that we call life; and it is *possible* that the nature of life lies outside the realm of the knowable, as the non-committal Prof. Barger suggested at the conference. Such

being our ignorance, we advance to a second proposition, that it is always useful to return to the bedrock of facts and seek to envisage *living*, if we cannot understand *life*. Living always means that living creatures act on their surroundings and are acted on by them. Taking the first letters of the three biological co-ordinates—organism, function, and environment—Prof. Patrick Geddes suggests as a descriptive definition of living—$O \rightarrow f \rightarrow e : E \rightarrow f \rightarrow o$. In condensed form, living is an ever-changing ratio between *Ofe* and *Efo*, or *Ofe*/*Efo*, the numerator aspect being prominent at one time, the denominator aspect at another. This is obviously no definition of 'life', since the words organism and function imply the whole mystery; yet it is a very useful positivistic conception; and it may save us from the fallacy of trying to define organism apart from environment. Whatever be the true inwardness of life, the facts that we study are $O \rightarrow f \rightarrow e : E \rightarrow f \rightarrow o$.

(3) It is always useful to get below superficial differences to fundamental resemblances. Thus it was a notable step when Huxley united birds and reptiles as Sauropsida, and a still greater when Claude Bernard justified Linné's term Organisata, by showing in detail the phenomena common to the life of plants and animals. On the other hand, there is danger in satisfying our desire for unity, or for continuity, by sticking the same label on things or processes which remain very different. Thus the word 'evolution' is used as a label for a variety of genetic processes which have not very much in common save that they are modes of becoming.

There is a tendency to do the same with the word 'life' or 'organism'. It is generally admitted that Herbert Spencer did more harm than good with his term 'social organism', and Whitehead has deliberately made the same mistake in the opposite direction, in his disclosure of the organism-like character of the atom. So our third proposition is that, when all is said, the orders of fact indicated for short by the terms 'matter', 'life', and 'mind' remain very different from one another. Perhaps it would be clearer to say that 'cosmosphere', 'biosphere', and 'sociosphere' are three different worlds, one within the other, each with its own concepts, categories, or descriptive formulæ. No one stands for continuity more firmly than General Smuts, yet he insists that 'matter', 'life', and 'mind' are disparate orders of fact. This does not mean that they are separated by hard and fast boundaries, for organisms are whirlpools of matter and energy, and the members of a human society are rational mammals, and mind is clearly emergent in many an animal. Yet if anything is gained, something is lost by speaking of the life of crystals, or the organism of the atom, or the fellowship of molecules, or the society of cells in the body. Organism, for example, is a clear-cut well-established term, and it should be kept for genuine organisms, not blunted by application to atoms on one hand or human societies on the other.

Thus our third proposition is that the domain of things, the realm of organisms, and the kingdom of man (where mind plays a dominant part) are three distinct orders of fact, each with its characteristics—distinct though they overflow and interpenetrate, distinct though their continuity is becoming increasingly clear.

(4) It is time to put an end to the pitting of mechanistic and vitalistic descriptions against one another, as if one must choose between them. Every reasonable vitalist, whatever school he represents, wishes good speed to chemico-physical analysis and description; his protest is that the sea of reality contains fishes which escape the chemico-physical nets. There is no chemical test for feeling; there is no balance that will weigh a purpose. Yet the vitalist believes in the reality of feeling and purpose; and is rather amazed that anyone can disagree with him. Every vitalist wishes to see bio-chemical and bio-physical analysis pushed as far as they will go, but care must be taken not to pretend that the bio-chemical and bio-physical concepts suffice for the description of the whole of life or living. It is also a little naïve to suppose that atoms and radiations and the like form a sort of bedrock of reality, the fact being that they are only certain aspects of reality which become clear when certain methods are used in certain fields.

Similarly, in the opposite direction, there are legitimate transcendentalisms, as when we refuse to leave out feeling or the like in our account of animals; or when we consider the possibility that something analogous to the mental aspect of an intelligent animal may be at work in the implicit organism which we call the developing ovum. Smuts suggests that mechanism and vitalism should both be discarded as mischievous survivals, but that is impossible. They represent two legitimate ways of looking at living creatures. It is true, however, that they require to be replaced by neo-mechanism and neo-vitalism, for the mechanistic formulations of to-day are not those of fifty years ago, and vitalism has also been changed by a deepening knowledge of the non-living and of the unconscious. Our fourth proposition is that

mechanistic and vitalistic descriptions are not only legitimate, but even necessary.

(5) The extreme mechanistic position is not that there is a chemistry and a physics of the living organism, for that is admitted by all; it is that the concepts of chemistry and physics suffice to cover the whole field of life. When Dr. J. S. Haldane punctures a mechanical description of the work of the kidneys or the lungs; or when Smuts points out that many of the reactions of organisms differ from those of non-living systems in being the unified responses of co-ordinated wholes of a higher order than, say, atoms or chemical compounds; or when Driesch shows how mechanistic formulæ fail to grip the facts of development, and so on, the mechanists point to what the future has in store in the way of complete mechanistic description. This is unanswerable, though it may seem optimistic. It remains, however, for the vitalist to point out that in the higher reaches of life the mental aspect is undeniable, and that mentality cannot be juggled out of mechanism. Moreover, to put a long argument briefly, a machine cannot have a theory that it is a machine. Our fifth proposition is that mechanistic methods are indispensable and invaluable, but have their dangers just like facile vitalistic ones, and do not lead to adequate descriptions of living.

(6) At the opposite pole is positive vitalism, ably represented at the conference by Prof. Wildon Carr, who maintained that mechanism is not to be supplemented, but is to be rejected as a wrong way of approaching the problem. He stood for the postulate of an 'entelechy', a positive principle in virtue of which an organism is an individual whole and acts as such. The essence of life is individual and purposive activity, and this is original and of the essence of reality. What we know of matter does not help us to understand life and mind.

A radical objection to this view is the apparent continuity of evolution. For it looks as if living organisms had emerged (at present one of the 'blessed' words) from non-living materials; it looks as if undeniable 'minds' or mental aspects had arisen as new syntheses in animals the ancestors of which were not more than latently mental, just as the clever child arises in individual development from an egg-cell, the 'mind' of which is far to seek. But Wildon Carr rejects the precedence of matter to life, and of life to mind.

In an interesting way Wildon Carr turns the tables on General Smuts by declaring that he is an entelechist without knowing it. According to Smuts, evolution has been a progressive emergence of higher and higher 'wholes', such as the atom, the cell, the vegetative organism, the animal with an embodied mind, and the human personality. A new 'whole' is a fresh synthesis the intrinsic nature of which admits of new agency, creativeness, and freedom. The progressive emergence of 'wholes' in Nature allows of the expression of fresh aspects of reality; and if it be asked why there should be this tendency to whole-making, Smuts replies, we think, that such is the nature of things. Within the scientific universe of discourse Smuts refuses to invoke any *deus ex machina*. Yet when he defines holism as "the ultimate synthetic, ordering, organising, regulative activity in the universe which accounts for all the structural groupings and syntheses in it, from the atom and the physico-chemical structures, through the cell and organisms, through mind in animals, to Personality in man", we are afraid that he lays himself open to Wildon Carr's charge of "using a wrong word 'holism' when the right word 'entelechy' was staring him in the face". Yet of the two formulators, we think that Smuts keeps nearer than Wildon Carr to the facts of the case; for holism emphasises continuity and evolution.

(7) Finally, it seems to us that the most tenable position is what may be called 'methodological vitalism'. Mechanistic descriptions are indispensable, and we owe to the mechanists in particular a deeper understanding of the environmental factor in living ($E \rightarrow f \rightarrow o$). But at its best, at present, mechanistic formulation is far from giving us an adequate account of the life of organisms. Vitalistic descriptions are also indispensable, for whether the organism has an entelechy at heart, or whether it is one of a long series of 'syntheses', or 'integrates', or 'wholes', its life cannot be adequately described in terms of mechanism. The vitalists have done good service in emphasising the organismal factor in living ($O \rightarrow f \rightarrow e$), and also, of course, the functioning factor, for life is *par excellence* activity, as Wildon Carr so well insists. But the scientific inquirer is not fond of 'principles' or 'entelechies', and he dreads 'vital forces' in disguise; so what can he do but maintain not a positive but a methodological vitalism? That is to say: as things are at present, the mechanistic formulation of organisms and their functionings in their environments does not answer the distinctively biological questions. Biology has concepts of its own at present irreducible to chemistry and physics: the living creature is a historic being enregistering its experience; it is a purposive individuality that gets things done; it grows, multiplies, develops, struggles, varies, and evolves; it often has a mind of its own.

Pavlov's Collected Addresses.

Lectures on Conditioned Reflexes: Twenty-five Years of Objective Study of the Higher Nervous Activity (Behaviour) of Animals. By Dr. Ivan Petrovitch Pavlov. Translated from the Russian by Dr. W. Horsley Gantt, with the collaboration of Prof. G. Volborth. Pp. 414 + 4 plates. (London: Martin Lawrence, Ltd., n.d.). 18*s.* net.

BEFORE 1927 there was no systematic account in the English language of the extensive investigations into cerebral function by Prof. Pavlov and his school, commenced in St. Petersburg a quarter of a century earlier. In that year, however, the Oxford Press, aided by the Royal Society, published the translation by Dr. Anrep of a course of lectures which had been delivered by Pavlov in 1924, and so gave to readers of English the first complete conspectus of those researches of which they had so long been deprived.

Dr. Gantt now adds to the resources of the literature by translating what are, in fact, Pavlov's "Collected Addresses"—collected over a period of twenty-five years. It is indeed unfortunate that Dr. Gantt has not used the term for the title of this volume and so eliminated any risk of its confusion with the synoptic lectures of 1924. A personal sketch of Pavlov forms an appropriate preface to a book with the autobiographical character which is inseparable from a set of forty-one lectures delivered at intervals during a long life of research, and Dr. Gantt has produced a vigorous account of the master himself, his outlook and his methods. In the substance of the lectures one finds much overlap and repetition, which are inevitable when the evolution of a research is described before different audiences at short intervals of time. But these re-statements sharpen the focus of the problem and present to the reader the living difficulties of the research.

The word 'reflex' has been given by Pavlov a much wider connotation than has ever been demanded of it by workers on the spinal cord and lower cerebral centres. The simpler reflexes are inborn and have an inevitable fatality of action. On the other hand, the conditioned 'reflexes'—conditional would have been a happier epithet, but it died unborn—are acquired during life by the training method, as Kalischer calls it. Pavlov prefers to define the conditioned reflex as "an act of synthesis by the [cerebral] hemispheres of the animal". The reflex is only a temporary affair, not lasting many weeks or months beyond the cessation of the events producing it.

From the beginning of the research, the Russian school has viewed the phenomenon from a sternly objective approach, even if in the early days that led to the extremity of imposing a fine in the laboratory "for the use of such psychological expressions as the dog guessed, wanted, wished, etc.". By training, a dog's mouth can be made to water before a meal (unconditioned stimulus) by some preceding visual, auditory, or cutaneous stimulus (conditioned stimulus). This is evidence of the employment of a certain nervous path possessing centripetal, central, and centrifugal elements, in fact the "reflex arc of the physiologist". On this objective basis the work of the Russian school has been pursued. Within the cerebral hemispheres lie the central elements of the reaction, here given unsubjective treatment for the first time so baldly as though to blast for ever speculation on their nature. Of the centripetal element, there is much of interest to physiologists concerning receptor organs and receptive apparatus ('analyser'). That the dog can distinguish as an excitatory stimulus (announcing-food) a tone of 1000 vibrations a second from one of 1012 as an inhibitory stimulus (announcing-no-food) is indeed remarkable. This feature, as well as the lack of colour discrimination and many other *notabilia*, is already familiar to readers of the treatise of 1927.

The heart of the problem which the Russian physiologists have set themselves is the nature of the central elements of the conditioned 'reflex'. One of the simplest examples of differentiation in the central nerve-mass is that between 100 and 96 metronome beats a minute. Nociceptive skin stimuli too can be brought, by inhibition of the 'defence-reflex', to have a benign implication and be used as conditioned stimuli for pre-prandial salivation. The complex events of spread or 'irradiation' of excitation and of inhibition through the central nerve-mass are shown to have well-defined temporal and spatial relations, which closely resemble the processes occurring in lower nerve centres on a humbler scale. The phenomenon of sleep as an irradiation of internal inhibition comes often within the purview of this study. The abnormal reactions of hysteria (strengthening of inhibition) and of neurasthenia (weakening of inhibition) are touched on.

Nevertheless, there are deep waters which objectivism plumbs uncertainly for the present. To say that a dog exhibits the 'guarding-reflex' when it is hostile to strangers in its familiar experimental room seems to be nothing more than the alteration of a label from 'instinct' to 'reflex'. But the

change in title may be justified if it heartens the strict objectivist to further research. When a dog shows resentment to being held in harness for experiment, it is said to show the 'reflex of freedom'. We are told, naïvely enough, "perhaps a sensitive dog". Especially in the later lectures there recurs the word 'temperament'—an uncontrollable but not entirely unstable factor dominating the whole field of research into acquired reflexes, intensifying the difficulties and demanding from the workers a fund of patience. To many critics this dominance of 'temperament' may appear to beg the whole question of the study being objective. At least, it presents problems for solution.

Dr. Gantt's translation deserves welcome, if only for the single reason that it enables us to follow chronologically the development of a subject which has been pursued by the Russian school with a virile endeavour worthy of the greatest traditions. Pavlov calls endeavour a 'reflex of purpose', pointing, be it said, to the Anglo-Saxon for its highest personification. However this quality may be named, it is surely that which lifts animals out of the category of mere flotsam, bewafted on an ocean of fatalism, and is none other than conation. In describing this 'reflex of purpose', Pavlov asks the question, "What is the chief condition for attaining a goal?" and supplies an Anglo-Saxon answer, "The existence of obstacles". Such, then, is the 'reflex' which has led him and his pupils to great achievements in physiology. E. G. T. L.

The Metallurgy of Iron and Steel.

(1) *Blast Furnace Practice.* By Fred Clements. Vol. 1: *General Principles; Source, Preparation and Handling of Raw Materials.* Pp. 538. (London: Ernest Benn, Ltd., 1929.) 63*s.* net.

(2) *Practical Steelmaking.* By Walter Lister. Pp. xii + 413 + 44 plates. (London: Chapman and Hall, Ltd., 1929.) 25*s.* net.

(3) *Photomicrographs of Iron and Steel.* By Everett L. Reed. Pp. xx + 253. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1929.) 20*s.* net.

METALLURGY is a science as well as an art, and its processes are of great interest to the physical chemist as well as to the technical man. As the need for more efficient production is more strongly felt, empirical and long-established methods of manufacture receive scientific study, and great improvements are made possible by the application of knowledge obtained in the laboratory, often without thought of any immediate use. A consequence of this is that there is an increasing demand for trained men in the industry, and the standard of knowledge of pure chemistry and physics which is required of them is much higher than it was even ten years ago. Hence the need for trustworthy books dealing with the several branches of the subject, suitable for readers who look for something more than the mere catalogue of processes and plant which has composed so many of the larger text-books of metallurgy in the past. The standard is being raised, and we expect of an author that he shall show an acquaintance with the scientific foundations of manufacturing processes as well as with the details of their operation. It is gratifying to find that many such works are now available, and the serious metallurgical student is being helped by having authoritative information put before him in a readable form.

(1) The blast furnace is one of the most interesting of all large-scale appliances used in industry. To a chemist approaching the metallurgy of steel for the first time it may seem strange that the production of crude pig-iron from the ore, followed by an elaborate process of refining, should have superseded so entirely the ancient direct process of making soft iron or steel from the ore in one operation, and that the efforts of so many modern inventors to return to the old method and to eliminate the blast furnace should have been so completely without result. Actually, the modern blast furnace, crude as it may appear, is an extraordinarily efficient appliance, when account is taken of all its by-products. It has evolved by gradual steps from the ancient furnace reducing a few pounds of ore at a time to the immense American furnaces with a production of as much as 1000 tons in twenty-four hours, whilst the combustible gases issuing from its throat, and formerly allowed to burn wastefully in the air, now supply the whole of the power needed by large plants.

Mr. Clements has already rendered great services to the metallurgical world by his compilations of facts concerning British blast furnace, Siemens furnace, and gas producer practice, contributed in the form of papers to the Iron and Steel Institute, and summed up in large folding tables which are to be found in use in many laboratories and works. He has now undertaken the task of writing a comprehensive text-book of blast furnace practice, for which there is a real need. The single volume originally projected has grown into three, the first of which is now before us. He has done his work well and conscientiously, and has been well supported by the publishers, so that the volume is

excellently printed and illustrated, the only objection which some readers (but not the reviewer) may raise being the unusual width of the page, making a long unbroken line. After certain general chapters the work treats of the sources and mining of iron ores, the supply of fluxes, the production of coke, the use of the hot blast, and the methods of handling raw materials. The actual construction of furnaces and of stoves is to follow.

Although information has also been collected from American and Continental sources, the book deals chiefly with English and Welsh practice, the interesting Scottish furnaces, working with splint coal, being omitted. The tables, however, contain full particulars of dimensions, charges, temperatures, output, and many other details of typical furnaces selected from many parts of the world, and this feature will be found invaluable. German practice receives fuller attention in the chapter on coke ovens. Methods of mining are treated of more fully than might have been expected in a work concerned with the blast furnace, and this section is of great interest, as is that which describes the methods of handling raw materials, a matter of great importance where the quantities are so enormous. The subject is discussed in a most readable manner, and Mr. Clements's book will become the standard treatise on the subject.

The weakest portion is that which deals with the metallography of cast iron and with the chemical reactions in the furnace. Although very full, and containing much that is of great interest, these chapters cannot be taken as representing the latest knowledge on what is admittedly a difficult subject. The great difficulty of obtaining equilibrium in laboratory experiments on the reactions between solids and gases has led to the publication of much inaccurate work, and the task of the scientific critic is a hard one. The reader who is interested in the physical chemistry of iron smelting will do well, therefore, to consult recent literature for the more accurate equations and equilibrium diagrams which have superseded many of those contained in these chapters. This, however, lessens in only a small degree the usefulness of a valuable book.

(2) Mr. Lister's volume is the most satisfactory book on practical steelmaking that we have yet seen. The author, a steel works manager, has a vigorous style, and has written an admirable account of the more important processes, in which he has no hesitation in expressing his own views, based as they are on an extensive experience. He is concerned only with the production of the ingot, the section on ingot structure and defects being short and rather perfunctory. For information on this subject one must look elsewhere, but the actual melting operations are treated with fullness and accuracy, whilst the important matters of furnace maintenance and repair are discussed with the knowledge which comes from familiarity. Furnaces are described with the aid of clear diagrams and photographs only so far as is necessary for an understanding of their working, and we are spared the masses of details from furnace builders' catalogues which occupy so large a space in many text-books.

Modern British practice is mainly dealt with, so that the Bessemer process is disposed of in two short chapters, and it is evident that the author looks on the acid Siemens process as the best for the making of good steel, although his account of the basic progress is full and fair. Probably metallurgists accustomed to the making of steel of the highest quality would speak more approvingly of the electric furnace than he does, but his warning that it is quite possible to make very bad steel in an electric furnace is one that should be taken to heart by less experienced melters. Much harm has been done to the use of the electric furnace by the impression, at one time too common, that any inferior material, once put into an arc furnace, could be made into steel of high quality. Crucible and high-frequency melting are not mentioned, and it is evident that the author has been chiefly concerned with the larger processes, the account of alloy steels being the least thorough portion of the book, only a few being included. Printing and illustrations are excellent.

(3) The idea of producing an album of standard metallurgical photomicrographs has appealed to many, and several such have been published. Whilst the student may no doubt derive useful information from the study of a series of typical structures, provided that the quality of the photographs is satisfactory, the extent of such benefit may easily be overrated. In regard to alloy steels, in particular, the structures vary in such a fashion that no amount of external help of this kind can replace a first-hand practical acquaintance with their changes under different conditions, whilst even for the simpler steels the range of variation is very wide. A reference album must therefore be suggestive rather than authoritative.

Bearing these limitations in mind, Mr. Reed has produced an excellent collection of photographs. With few exceptions, grey cast irons being the most conspicuous, the structures are clearly reproduced, and sufficient data are given to allow of a check by

repeating the experiment for one's self. The half-tone blocks are not comparable in beauty with the collotype plates of the admirable German album, nor do they cover so wide a field, but they include most of the types which will be met with by the young metallographer in practice. The book has been made unnecessarily large and heavy by the excessive number of half-titles and blank pages, combined with the use of a heavy glazed paper. It will no doubt be found most useful by American students, for whom it was written. The high standard of photography of metal specimens reached by some metallographers on the other side of the Atlantic is admired by all, and Prof. Sauveur, who contributes a preface to the present work, has done much to bring about that excellent result. C. H. D.

Studies of Fungi.

(1) *The Gasteromycetes of the Eastern United States and Canada.* By Prof. W. C. Coker and Prof. J. N. Couch. Pp. ix + 201 + 123 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1928.) 55*s.* net.

(2) *Comparative Morphology of Fungi.* By Prof. E. A. Gäumann. Translated and revised by Prof. C. W. Dodge. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiv + 701. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 37*s.* 6*d.* net.

(3) *Kryptogamenflora für Anfänger: eine Einführung in das Studium der blütenlosen Gewächse für Studierende und Liebhaber.* Begründet von Prof. Dr. Gustav Lindau. Fortgesetzt von Prof. Dr. R. Pilger. Band 1: *Die höheren Pilze. Basidiomycetes, mit Ausschluss der Brand- und Rostpilze.* Von Prof. Dr. Gustav Lindau. Dritte Auflage völlig neu bearbeitet von Prof. Dr. Eberhard Ulbrich. Pp. xii + 497 + 14 Tafeln. (Berlin: Julius Springer, 1928.) 29·50 gold marks.

(4) *Fungi: an Introduction to Mycology.* By J. Ramsbottom. (Benn's Sixpenny Library, No. 68.) Pp. 80. (London: Ernest Benn, Ltd., 1929.) 6*d.*

IT is no secret that in large groups of fungi systematics have been in a bad way. Different authors have used different specific and even generic names for the same thing, and, on the other hand, the same specific name has often been used in different localities for different organisms. It is becoming a commonplace, at least in certain groups, that one of the first necessities for correctly interpreting the author's use of a name is the examination of material which at some time has been authenticated by that author. Many observations on fungi are, from their nature, critical, so that an account, or description, or figure of a fungus by any given author really represents a statement of his opinion about it. If the views of several writers become compiled into one account, this account does not necessarily represent the views of any first-hand observer. The advance of mycology is therefore dependent on the accumulation of authenticated material and of the authentic opinions of first-hand observers. Some such view must be in the mind of any reader of the books now under review.

(1) In the first book on our list, the authors have produced what has every appearance of being a first-class handbook of the East American Gasteromycetes. They have taken full opportunity of qualifying themselves for the work; they have examined numerous specimens, are well abreast of the world literature, and one of them has visited the classical European herbaria. Of late years, photography has been developed to supplement descriptions, but scarcely before on this munificent scale except, perhaps, in some books on the Agarics. More than a hundred plates are devoted to photographs of specimens and a further twenty to careful drawings of spores and other microscopical detail. There are artificial keys to the families, genera, and species. Each species is fully described in English from specimens when these were available. When reliance is placed on the descriptions of other writers their names are given. Under each species all approved published illustrations are cited, together with the available collections from eastern America, but not, unfortunately, the bibliographic origin of the species. The geographical area covered is from the east coast to the Mississippi, but the writers have not allowed themselves to be unduly cramped by this limitation.

Altogether one feels that this is the real thing, a full illustrated account of the genera and species of a group small enough to be known personally to the authors. Whatever questions may later emerge as to the range of variation of any given species, no difficulty should be experienced in establishing the forms on which the present authors rely for maintaining the species which they have recognised.

(2) Gäumann's great work has now been translated into English. The German original has

previously been reviewed in NATURE (vol. 117, p. 820), and its general theme explained. The relationships of the fungi are considered and great stress is laid on the bearing of cytological work on affinity. The English translation renders this account very much more available to the student, and it may fairly be said that the book is indispensable. The translator has aimed at presenting Gäumann's views rather than giving a literal translation, and has not hesitated to introduce modifications suggested by two years' additional research. Out of the hundred and twenty odd orders and families recognised, alterations, sometimes extensive, have been made in the treatment of about one-tenth, a sufficient indication of the rate of progress during this brief period.

While admiring the performance, one is apt in some sections to have a sense of insecurity, to feel that there is a veil between the reader and authentic opinion. The copious bibliography is intended to bridge this gap, and, in fact, is often sufficient. Take the statement, "*Ceratostomella fimbriata*, the cause of black rot of the sweet potato, has an imperfect stage formerly known as *Sphæronema fimbriatum*" (p. 262). A reference to the literature cited shows that there has been a misconception. Again, the legend to text figure 145 reads: "*Pleospora herbarum* 1. Section through immature perithecium. . . . After Arnaud 1918." Reference to Arnaud's paper shows that his figure is entitled "*Pleospora* sp. (Type *Pl. herbarum*)", and that it has been 'improved' in redrawing. On the literature cited, Fig. 145 does not represent an authentic opinion of the structure of *Pl. herbarum*. At other times the descriptions of the figures do not truly convey the views expressed in the text. The legend to Fig. 179 reads "*Sphærulina intermixta*. Its growth forms known as *Dematium pullulans*. . . . After Brefeld." On the next page we read, "This type of germination has not been reported elsewhere, and probably was based on impure cultures". A more serious conflict of figure and authentic opinion (avoided in the original German) occurs on p. 325 with *Sclerotinia sclerotiorum* and *Botrytis cinerea*.

In so vast an effort such slips are inevitable and do not greatly impair the value of the work. No author has, for many a year, covered this whole field, and it is perhaps doubtful if a single author will feel justified in again attempting it.

(3) The last two books are on a different plane. The first volume of the third edition of the "Kryptogamenflora für Anfänger" has been much enlarged—to twice the size of the corresponding volume of the second edition. It covers all the genera of the Basidiomycetes, excluding the rusts and smuts. A general part introduces the reader to the subject—collection, examination, preservation, and classification of fungi—and then he is led straight into the attempt at naming them with the help of keys, short descriptions, and a number of line drawings.

(4) The British contribution to our knowledge of fungi is represented in Mr. Ramsbottom's little book, in which he neatly skims the cream of current biological work on the group. Fungi are not animals or truly plants, but they lay toll alike on the living and the dead of both; they have a *flair* for intimate association with the dominants in many a natural habitat—forest, heath, rock, ice, and desert, and it is now held that they form an integral part of the 'essential guts' of several genera of insects. Their bizarre habit of digesting their food before they eat it provides the starting-point of several thriving industries, and a fungus has before now affected the course of political history. The judicious examples chosen should lure the public into an interest in these fascinating organisms, and will, at the least, introduce them to strange realms of knowledge.

Enzyme Research.

Die Methodik der Fermente. Herausgegeben von Carl Oppenheimer und Ludwig Pincussen. Lieferung 4. Pp. 7 + 945-1264. 28 gold marks. Lieferung 5. Pp. xxx + 1265-1578. 28 gold marks. (Leipzig: Georg Thieme, 1928 and 1929.)

THIS treatise, forming Vol. 3 of Prof. Oppenheimer's "Die Fermente und ihre Wirkungen", of which it forms the complement, was reviewed in our columns when the first 944 pages of the text had been published (see NATURE, Nov. 3, 1928, p. 676). We are now in a position to deal with the entire work.

The work is divided into three main sections, which are subdivided into sub-sections and chapters, the text being written by leading authorities drawn from all parts of the world. Essentially it is a practical treatise, dealing with methods rather than with theories, but here and there it has been found necessary to introduce theoretical considerations by way of making the text clear. There are 461 illustrations of the most recent forms of apparatus, including diagrams and curves. The value of the book is considerably enhanced by these. With few exceptions the methods of isolating, purifying, and estimating the power of enzymes are

based on work of comparatively recent date, yet so great has been the activity in this field of research during the past twenty or thirty years that it is well-nigh impossible for any individual to piece together the voluminous fragments of the literature without the aid of such a treatise as the one before us. Hence the *raison d'être* of the work.

The authors have been exceedingly happy in their choice of contributors, and since a commentary on each individual chapter is out of the question on account of their large number, the selection of a few of the chapters must suffice for this purpose.

To Prof. P. A. Levene has been entrusted the preparation of the chapters on the nucleoproteins and their derivatives, and the phosphatides, whilst Prof. Neuberg and Miss M. Kobel deal with the sugar phosphates and with phytin. The significance of the hexose phosphates, discovered independently by Harden and by Iwanoff in 1906, in alcoholic fermentation is well known, and the recent work of Robison goes to show that they are concerned in ossification, whilst that of Embden shows that they play a rôle in the contractile and recovery processes of the muscles. They also appear to take part in the formation of polysaccharides.

The matter concerning the proteases covers 155 pages of the text. Dr. W. Grassmann deals with the detection, isolation, and estimation of those of vegetable origin, and Dr. E. Waldschmidt-Leitz with those of animal origin. Dr. H. Kleinmann describes nephelometric methods for investigating trypsin, and Prof. Pincussen deals with the Abderhalden reaction.

The sub-section on demolases covers no less than 313 pages of text. What may be regarded as a general chapter is written by Dr. F. G. Fischer. It is concerned with oxidations with molecular oxygen, oxido-reduction reactions, peroxidase reactions, and catalysis of hydrogen peroxide. Prof. Thunberg has written the chapter on acceptor methods, dehydrases of the carboxylic acids, and on oxido-reduction reactions. All the latest methods are here clearly described. The chapter on the sulphur system is from the pen of Sir F. Gowland Hopkins, who gives a complete and succinct account of our knowledge of glutathione, its preparation, functions, and reactions. Resting bacteria are dealt with by Dr. J. H. Quastel. Prof. Neuberg with his colleagues contributes chapters on alcoholic and lactic fermentation, lact-acidogen, phytochemical reduction, carboxylase carboligase, and alcohol dehydrase. The chapters on yeast zymase and on the co-enzyme of yeast are written by Prof. A. Harden. Aldehydrase and oxygenase are dealt with by Prof. A. Bach. Prof. E. Newton Harvey contributes a chapter on luciferase, a substance having many of the characteristic properties of an enzyme which plays a rôle in plants and animals by the production of light.

The methods described under the heading of capillary analysis by Prof. J. Grüss are of quite a novel character. He gives directions for the detection of enzymes in tissues by micro-chemical and macro-chemical methods.

A subject matter index is appended.

We believe that sufficient comment has now been made on the book to warrant us in recommending it strongly, with the previous two volumes, to those engaged in the study of enzymes. Without doubt it and its companion volumes constitute the most complete and up-to-date treatise on the subject.

ARTHUR R. LING.

Our Bookshelf.

(1) *Romance of the Moon.* By Mary Proctor. Pp. xii + 262 + 7 plates. (New York and London: Harper and Bros., 1928.) 7*s.* 6*d.* net.

(2) *The Story of the Moon: a Description of the Scenery of the Lunar World as it would appear to a Visitor spending a Month on the Moon.* By Garrett P. Serviss. Pp. xii + 248 + 28 plates. (New York and London: D. Appleton and Co., 1928.) 10*s.* 6*d.* net.

THESE two popular books on the moon are in many ways complementary. There is very little overlapping of subject matter, and both may be read with advantage by those whose interest in our satellite has been aroused.

(1) Miss Proctor's book deals with a wide range of subjects connected with the moon in a pleasantly discursive manner which makes easy reading. An introductory chapter on "The Magic Spell of Moonlight" is followed by explanations of the moon's motions, phases, eclipses, the tides, and kindred phenomena, farced with literary allusions or quotations bearing on the subject. The quotations are so numerous and lengthy throughout the book as to give it in places the appearance of merely a well-arranged anthology.

The principal physical features of the moon are briefly described, illustrated by photographs taken with the 100-inch Mount Wilson telescope, and various theories as to their origin explained. The second half of the book is devoted mainly to popular superstitions, folk-lore, and weather prophecies connected with the moon. This section includes an interesting chapter on facts and fallacies involved in various suggested methods of travelling to the moon, with Prof. Goddard's rocket used as a text.

(2) Mr. Serviss is concerned mainly with descriptive selenography. He leads beginners by pleasant stages to an acquaintance with the chief features of lunar topography and an understanding of their

nature, by discussing a series of 21 photographs taken at the Lick Observatory. These represent the moon in successive stages throughout a lunation, the principal objects being pointed out and discussed as they become illuminated by the sun. A few special districts, such as Theophilus, Tycho, and Mare Serenitatis, are described more in detail by the aid of photographs on a larger scale. There is a brief introductory chapter which, with occasional later interpolations, explains the moon's motions, size, phases, and similar matters.

The book is written in the form of conversations between the author and a conveniently inquisitive friend who study the photographs together. This style, though possibly unpleasant to some, is not unduly obtrusive, and has the advantage of sustaining interest in the subject in an easy and natural manner.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 13, 1928. Pp. 760. (London: Society of Chemical Industry, 1929.) n.p.

THE thirteenth issue of this important annual review of applied chemistry is no less welcome than its predecessors; it conforms to the high standard which one is accustomed to expect as regards both quality of material and extent of the ground surveyed. The present volume, like that for 1926, contains a chapter dealing with explosives (J. Weir), the survey in this case covering the two-year period. The sections concerned with general matters, plant, and machinery (A. J. V. Underwood); mineral oils (A. E. Dunstan); colouring matters and dyes (C. Hollins); soils and fertilisers (E. M. Crowther); sugars, starches, and gums (L. Eynon and J. H. Lane); the fermentation industries (H. Lloyd Hind and F. E. Day); and foods (F. S. Aumonier and J. King) have again been entrusted to those who contributed similar chapters last year, whilst the other reports are: fuel (H. J. Hodsman); gas, carbonisation, tar and tar products (H. Hollings); fibres, textiles, cellulose, and paper (J. C. Withers); bleaching, dyeing, printing, and finishing (L. G. Lawrie); acids, alkalis, salts, etc. (C. J. P. Bateson, H. M. Broadhurst, A. Lamble, and A. Williams); glass (H. W. Howes); refractories, ceramics, and cements (W. J. Rees); iron and steel (W. H. Hatfield); non-ferrous metals (A. R. Powell); electrochemical and electrometallurgical industries (H. T. S. Britton); oils, fats, and waxes (T. P. Hilditch); paints, pigments, varnishes, and resins (C. A. Klein, T. H. Barry, R. P. L. Britton, R. G. Daniels, and W. E. Wornum); india-rubber (D. F. Twiss); leather and glue (F. C. Thompson); sanitation and water purification (J. Haworth); fine chemicals, medicinal substances, and essential oils (W. H. Linnell); and photographic materials and processes (E. P. Wightman).

Although it is scarcely probable that there are many chemists who are unaware of the existence of this annual volume, it is perhaps worth mentioning that the reports, whilst detailed and abundantly provided with references, do not pretend to exhaustiveness, but rather aim at providing a readily assimilable summary of the main directions of advance. Hence their perusal forms a most valuable prelude to the study of the abstract literature in the examination of chemical problems.

A. A. E.

Volumetric Analysis. By Prof. Dr. I. M. Kolthoff, with the collaboration of Dr. H. Menzel. An authorised translation based upon the German edition by Prof. N. Howell Furman. Vol. 1: *The Theoretical Principles of Volumetric Analysis.* Pp. xvii+289. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 15*s.* net.

THE volume under notice is perhaps the first successful attempt to gather together the underlying principles of volumetric practice. The author has utilised such parts of his previous publications on potentiometric methods and indicators as have a bearing on volumetric analysis. It may be stated at once that this theoretical introduction should prove invaluable to practising chemists and to students generally, for it gives precise information on titration and neutralisation curves, oxidation-reduction indicators, complex ion titrations: matters which are often considered academic and therefore neglected.

The practical bearing of the 'solubility product' is adequately dealt with in Chapter i., and the usefulness of this part of the work is increased by inclusion of tables of solubility products in the appendix. Chapter vii. deals with so much of adsorption phenomena as is required for the purpose of discussing the question of 'dragging down' by precipitates resulting in errors near the equivalence point. This part naturally leads up to the work of Fajans, Taylor, and others on adsorption indicators, and adsorption of ions by precipitates. The 'titration error' arising from the relative insensitivities or sensitivities of indicators is dealt with quite fully for precipitations and neutralisation reactions. Addition and condensation products are considered, perhaps not so fully as they deserve. A section on stability of stock solutions will be found useful in practice. Readers will be grateful to the author for putting into their hands in one volume a much-needed discussion of the essentials of volumetric analysis. J. J. F.

Diamond: a Descriptive Treatise. By Dr. J. R. Sutton. Pp. xii+118+36 plates. (London: Thomas Murby and Co.; New York: D. Van Nostrand Co., 1928.) 15*s.* net.

FOR many years Dr. Sutton has devoted himself to the study of the diamond from various points of view, and in this book he has brought together the results of his painstaking observations. The language used is as simple as is possible consistent with scientific treatment, and the book should prove of great interest to the general reader as well as to the mineralogist. With regard to crystallography, the point is emphasised that the almost universal form is the octahedron, rarely the cube, and that nearly all crystals are really octahedra, more or less disguised; the idea that the funda-

mental form is really the tetrahedron is rejected. Evidence from X-ray examination seems to show that the structure is holohedral. This discussion of structure is illustrated by some very good photomicrographs, and by a great number of pencil drawings, which might have been made a little darker with advantage.

On that highly controversial subject, the origin of the diamond, Dr. Sutton concludes that the crystals produced in Moissan's famous experiment were not diamonds at all: with this conclusion most people will probably agree. He points out that the majority of crystals do not show any evidence of early free crystallisation from the magma, but quite the reverse: he thinks they were formed as a late constituent on the margins of eclogite xenoliths, at first as plastic crystals, becoming solid later and growing by successive superposition of similarly plastic shells on the nuclei thus formed, and the temperature at the time of formation must have been comparatively low. This conception of plastic diamond is a difficult morsel to swallow. R. H. R.

A Text-book of Systematic Botany. By Prof. Deane B. Swingle. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiii + 254. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 10*s.* net.

THERE are too few text-books that present the subject of taxonomy as other than a system of pigeonholes, and a work which aims at outlining its more philosophic aspects is welcome. The subject matter of Prof. Swingle's book is divided into two sections, of which the first, occupying rather less than one-half of the text, is devoted to a consideration of the principles and methods of taxonomy. The second section treats of some sixty families of seed-plants selected on the basis of their importance. The treatment of these latter is somewhat cursory and follows conventional lines. The omission of a consideration of the affinities of the selected groups indicates that their inclusion has scarcely been utilised to elucidate the principles dealt with in the previous section. With regard to this latter, there is much to be commended, but even here sufficient thought has not been devoted to the needs of the student. A knowledge of general botany is assumed, but where terms are defined these should at least be helpful. The statements that "a variant is a form arising by variation" and that "a mutant is a form arising by mutation" will scarcely assist the uninitiated, whilst the use, in this general manner, of the term 'form', which has a definite technical connotation in taxonomy, is at least unfortunate.

How to Enjoy the Starry Sky. By Marcus Woodward. (People's Library.) Pp. 238 + 8 plates. (London: Hodder and Stoughton, Ltd., 1928.) 2*s.* 6*d.* net.

THIS book differs from most popular books on the stars, both in purpose and style. It makes no attempt to explain the elements of astronomy, aiming rather to surround the celestial bodies with interesting associations of a literary or legendary character, thus arousing an interest in the subject which may lead to personal observation and the perusal of other books. Apart from three short chapters on the moon, planets, and comets, the greater part of the book is concerned with the constellations. The more important are described in turn, illustrated by a series of drawings representing the traditional figures, and in many cases the meanings of the star or constellation names, as well as legends connected therewith, are given. Interesting quotations from literary sources, and popular beliefs, superstitions, or quaint sayings, form a prominent feature in addition to a certain amount of astronomical information concerning the principal stars or other objects found in each constellation. The whole forms a very readable book, which can scarcely fail to interest and amuse the more advanced as well as the beginners for whom it is intended.

Three Minute Talks about Children. By Estelle Cole. Pp. 64. (London: The C. W. Daniel Co., 1928.) 2*s.* 6*d.* net.

IN this unpretentious little book Dr. Cole discusses some of the family relationships and shows the effect on the child of his mental environment. People are apt to forget that, although the material environment may be the same for each child in a family, there is one factor that can never be the same, namely, the position in the family with regard to the others. Here is described the problem of the only son, the middle child, the baby. Different types of behaviour ranging from the over-good to the extremely difficult are illustrated and diagnosed and the advice offered is expressed in simple terms.

The articles are all short and to the point, and if, by reading them, intelligent parents can be led to look at home conditions sometimes from the point of view of the child, a very valuable change of point of view will have been achieved. It is almost inevitable with such a form of presentation that some of the problems will seem too easy and some generalisations too sweeping, but the booklet should nevertheless prove very useful.

Principes et formules de l'hérédité Mendélienne. Par Prof. L. Blaringhem. Pp. xiii + 195. (Paris: Gauthier-Villars et Cie, 1928.) 40 francs.

THIS book gives a general account of the modern work on Mendelism, with particular reference to cultivated plants such as flax, peas, and barley. It is divided into three sections: (1) Mendel's laws and their applications; (2) mosaics and the linkage of characters; (3) formulæ, tables, and corollaries. The last is perhaps the most useful, as it brings together in summary form the various mathematical developments of Mendelism, including some of the methods and formulæ of Johannsen, Jennings, Pearl, and others for determining the results of different systems of crossing and of inbreeding, sex-linked inheritance, etc. The earlier part enters into details of the interpretation of Mendel's original experiments. Another chapter is on 'nuclear mosaics' (crossing-over) in *Drosophila* (spelled *Drosophyla* throughout).

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A New Connexion between the Absorption Spectrum of Hydrogen and the Many Lined Spectrum.

IT will be recalled that Dieke and Hopfield showed that the absorption bands of H_2, which are located in the extreme ultra-violet (about 1000-1500 A.), were due to transitions up from the ground level of H_2, which they called A, to two higher electronic levels which they called B and C respectively. Two years ago I found the emission bands in the visible which go down to the B, or $2\ ^1S$, level. In a series of papers (*Proc. Roy. Soc.*, A, vol. 123, pp. 54, 466; vol. 124, pp. 50, 69; vol. 125, p. 23; 1929) Dr. Davidson and I have been able to show that these bands comprise a large number of distinct band systems and contain a very large part of the total strength of the visible emission spectrum of H_2. Various attempts have been made from time to time to discover bands in this spectrum which end on Dieke and Hopfield's C level, but, until recently, nothing at all convincing has resulted from these efforts.

I have now found a number of band systems which end on this C state. These systems all have initial states which are identical with one or other of the initial states of the bands ending on the $2\ ^1S$ level. Most, though not all, of the bands are weak, but there is no doubt about their authenticity as the frequencies of the lines are connected by combinations which are known with great accuracy. The initial levels from which the transitions arise are those denoted by Richardson and Davidson as $4\ ^1A$, $4\ ^1B$, $4\ ^1C$, $4\ ^1\chi$, $4\ ^1E$, $3\ ^1A$, $3\ ^1C$, and $3\ ^1O$. Possibly $3\ ^1K$, $3\ ^1L$, $3\ ^1N$, and ^1Q may have to be included in this list, but there seem to be no bands coming from $4\ ^1\Psi$, $3\ ^1B$, and $3\ ^1M$. So far as they have been investigated, the band systems have the character of band sequences similar to those of the α, β, and other systems ending on $2\ ^3S$ rather than the progressional character of the bands ending on $2\ ^1S$. The bands which arise from the initial states to which the electronic quantum number 4 has been assigned lie in the green, the others in the infra-red.

The bands all have P', Q, and R' branches, but these are not equally developed. Most of them resemble the α, β, etc., bands in having the Q branches strongest, R' intermediate, and P' weakest, but the bands starting from $4\ ^1E$ have R' stronger than Q. The lines in each band have an alternation in intensity corresponding to a ratio in the weights of the alternate states of about 3 to 1. The stronger lines are $Q2$, $Q4$, $R'3$, $R'5$, $P'3$, $P'5$ in my numbering, which is one unit higher than that used by Hori and others. The transitions are governed by the same exclusion rules as operate in the other band systems of H_2. The doublet differences due to the non-coincidence of the R' P' with the Q final levels increase rapidly with rotational energy.

The final term differences, both vibrational and rotational, agree with those of Dieke and Hopfield's C level to the accuracy of the ultra-violet data, and the analysis of the final level confirms the correctness of Hori's analysis of the Werner ($C \longrightarrow A$) bands. This is important for several reasons, but I shall mention only one. It shows that this C level is something different from the initial level of Richardson and Davidson's infra-red bands. This initial level is quite distinct from the final level of the α, β, etc., bands, and both these levels have total (electronic) quantum number 2. There is also in the initial level of the bands originally called $3\ ^3S \longrightarrow 2\ ^3S$ by Richardson and Das what is almost certainly another 2 level. We thus have certainly 4, and probably 5, 2 levels in the spectrum of H_2. It is impossible, on any accepted principles, to classify all these 2 levels as singlet levels (or all as triplet levels). I therefore think that these new results greatly strengthen my view that the α, β, etc., and the $^3S \longrightarrow 2\ ^3S$ bands should be assigned to the orthohelium-like (triplet) systems, and all the other known band systems to the parhelium-like (singlet) systems.

I think it probable that the following classification of a number of the more important levels will turn out to be correct: *Parhelium-like (singlet) levels.* $A = 1\sigma\ ^1\Sigma$, $B\ (= 2\ ^1S) = 2\pi\ ^1\Sigma$, $C = 2\pi\ ^1\Pi$ (= final level of present systems), infra-red $= 2\sigma\ ^1\Sigma$, $3\ ^1O = 3\sigma\ ^1\Sigma$, $3\ ^1C = 3\delta\ ^1\Sigma$, $3\ ^1A$ and $3\ ^1B = 3\delta\ ^1\Pi$, ^1Q and the progressions about $\lambda 4200 = 3\delta\ ^1\Delta$, $4\ ^1E = 4\sigma\ ^1\Sigma$, $4\ ^1C = 4\delta\ ^1\Sigma$, $4\ ^1A$ or $4\ ^1B$ (possibly both) $= 4\delta\ ^1\Pi$, $4\ ^1\chi = 4\delta\ ^1\Delta$. *Orthohelium-like (triplet) levels.* Lower levels of α, β, etc., bands $= 2\pi\ ^3\Sigma$, upper levels of these bands $= m\pi\ ^3\Pi$ ($m = 3$, 4, etc.), upper levels of the $^3S \longrightarrow 2\ ^3S$ (or $^3S' \longrightarrow 2\ ^3S$) bands $= m\sigma\ ^3\Sigma$ ($m = 2$, 3). It would take too much space to defend this classification in detail, but a complete account of these systems and the conclusions to be drawn from them will be published elsewhere. For other views, reference may be made to a recent communication in NATURE by Dieke (June 29, 1929, p. 979) and to articles in the *Zeitschrift für Physik* by Weizel and by Finkelnburg and Mecke. It may be permissible to add that the number of established electronic levels in H_2 is now about forty.

O. W. RICHARDSON.

Relationship between h, c, and e^2.

I HAVE been trying to find experimental or indirect evidence bearing on Prof. Eddington's suggestion (*Proc. Roy. Soc.*, Jan. 1929) of the relationship

$$\frac{ch}{2\pi e^2} = 136. \quad . \quad . \quad . \quad (1)$$

For six quantities such as the six fundamental quantities c, e, h, G, m, and M (the 'mass' of the proton), I find that the *a priori* chance of there being a non-dimensional product or quotient of any three or less of the quantities, of which one may be raised to the second power, is between 1 : 1 and 1 : 5. Two such products are, however, found, namely, ch/e^2 and M/m. Further, assuming the approximate order of magnitude of the six quantities, the chance of a product chosen at random falling between 2000 and 1/2000 in value is about 1 : 7. But the values found are 860 and 1840 approximately. It is not, therefore, easy to attribute these results to chance.

On the other hand, if the non-dimensional constants 860 and 1840 are like those that usually occur in physics, I have shown (*Phil. Mag.*, April 1929) that they are only to be expected once in about 860 and 1840 such constants, respectively. Amongst 1125 constants I have only found one so large as 316; and the only case that I remember comparable with those now considered is the Reynolds number referring to flow through a straight tube just ceasing to be turbulent. The magnitude of the numbers is illustrated by the complexity of the suggestions $2\pi(|5 + 2^4) = 2\pi\ .\ 136$; and $(1^2 + 2^2 + 2^2 + 3^2 + 3^2 + 4^2)^2 = 1849$ (see Enos E. Witmer, NATURE, Aug. 3, p. 180).

Apart from the experimental evidence given by Millikan's work, tending to show that the number in equation (1) is not exactly 136, there is similar evidence given by Bohr's theory for the Balmer series. Thus, writing Rydberg's constant for hydrogen

$$1{\cdot}0968 \times 10^5 = \frac{2\pi^2}{c(1 + m/M)(e/m)} \cdot \frac{e^5}{h^3} \quad . \quad (2)$$

(e being in e.s.u.), and eliminating h between (1) and

(2), the product of e/m and e should be obtained very accurately, as the errors in the values of Rydberg's constant, c and $(1+m/M)$ are very small. This product corresponds to pairs of values such as

$$\left.\begin{matrix} e/m \text{ (e.m.u.) } 1{\cdot}776 \times 10^{7} \\ e \quad \text{(e.s.u.) } 4{\cdot}867 \times 10^{-10} \end{matrix}\right\} \text{ or } \left\{\begin{matrix} 1{\cdot}797 \times 10^{7} \\ 4{\cdot}810 \times 10^{-10} \end{matrix}\right.$$

But evidence that e/m is not appreciably larger than $1{\cdot}776 \times 10^{7}$ is given by *each* of the following :

(i) deflection of streams of electrons ;

(ii) the Zeeman effect ;

(iii) e/M for the hydrogen ion in electrolysis, together with M/m from comparison of the Balmer and Fowler-Pickering series.

Similarly, evidence that e must not be assumed appreciably larger than $4{\cdot}810 \times 10^{-10}$ is given by *each* of the following :

(iv) the charge on an α particle ;

(v) equation (1) together with h/e deduced from the photoelectric effect and from black-body radiation ; as well as

(vi) e (Millikan).

This indicates that one of equations (1), (2) is in error ; but the agreement of (i) and (ii) with (iii) tends to confirm equation (2), and hence throw the doubt on equation (1).

W. N. BOND.

Department of Physics,
University of Reading, Aug. 19.

Heat of Adsorption of Oxygen and Nitric Oxide on Charcoal.

MARSHALL and Bramston-Cook (*J.A.C.S.*, **51**, 2019 ; 1929) have measured the differential heat of adsorption of oxygen on activated charcoal and conclude that the heat of adsorption approaches a maximum value of 89,600 cal. per gm. mol. of oxygen as the amount of gas adsorbed approaches negligible dimensions. They refer to the work of Garner and McKie (*J. Chem. Soc.*, **130**, 2451 ; 1927 ; cf. Far. Soc., 461 ; 1926), who found at low surface concentrations a heat of adsorption of 5000 cal./mol., and observed that the heat rose to a maximum value of 71,000 cal. as the surface concentration of oxygen increased and then fell off at still higher concentrations. These values were given by an experimental arrangement in which a thermocouple was embedded in the middle of a mass

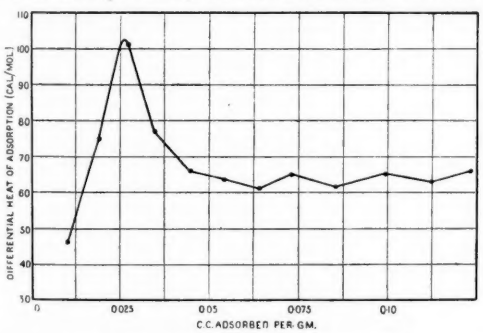

FIG. 1.—Oxygen adsorbed on charcoal at 20° C.

of charcoal. Marshall and Bramston-Cook suggest that it is desirable to repeat this work with thermocouples placed at different points throughout the charcoal.

During the last two years, the work of McKie has been repeated, and in the course of the research measurements similar to those suggested have been made. These have brought to light the fact that at high vacua carbon is relatively a bad conductor, and have also shown that at low oxygen concentrations the gas did not distribute itself uniformly throughout the mass of the charcoal grains. On this account, the vacuum calorimeter employed by McKie was made adiabatic, thereby preventing loss of heat from the calorimeter during measurement. Under these conditions, two thermocouples, the junction of one placed in the middle and that of the other placed on the outside of the mass of charcoal, gave the same rise in temperature. With this apparatus, the curves in Figs. 1 and 2 have been obtained for the differential heats of adsorption of oxygen and nitric oxide respectively on charcoal.

In these experiments, 0·007–0·010 c.c. of gas per gram of charcoal were added at a time. For oxygen

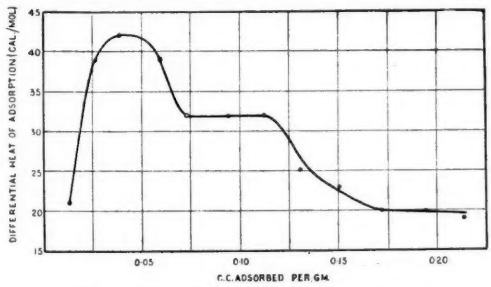

FIG. 2.—Nitric oxide adsorbed on charcoal at 20° C.

adsorbed on charcoal, the heat rises from 46 cal./mol. to 100 cal./mol. by the third admission and then falls to 65 cal., at which value it remains constant except for a curious type of alternation. The maximum occurs when 0·025 c.c. of oxygen per gram of charcoal had been adsorbed. This maximum shifts after long-continued heat treatment at 950° C. to lower surface concentrations. The American authors in their measurements added 0·03 c.c. oxygen per gram charcoal at a time, so that their surface concentrations were greater than ours. Also they gave the charcoal a preliminary treatment at 1000° C. for 60 hours.

For the same charcoal, the maximum heat of adsorption of nitric oxide occurs at somewhat higher surface concentrations than for oxygen. The alternation beyond the maximum does not occur for nitric oxide. There is a definite step on the curve indicating the presence of areas of different activities on the charcoal surface.

Kistiakowski and Taylor (*J.A.C.S.*, **49**, 2200 ; 1927) have observed similar maxima on the curves for the differential heats of adsorption of hydrogen on metals. We have not been able to observe the effect in the reaction of oxygen with finely divided copper, but this may be due to the fact that the surface concentrations employed were too high. With oxygen on copper, the maximum heat occurs at the lowest surface concentrations used.

The maximum value for the heat of adsorption of oxygen on charcoal which was obtained for single admissions of gas occurs when 0·12 c.c. oxygen is added per gram of charcoal. The value, 89 cal., agrees with that of Marshall and Bramston-Cook. The value obtained probably depends on the nature of the charcoal.

It is difficult to decide whether the above phenomena are due to activation of the carbon surface or to incompleteness of the reaction between oxygen and carbon at low surface concentrations. The experimental evidence is, however, in favour of the latter hypothesis.

H. I. BULL.
W. E. GARNER.

University, Bristol, July 30.

Natural Selection.

THE confusions and obscurities in Prof. MacBride's recent letter (NATURE, Aug. 10, p. 225) may perhaps excuse some of us if we pause awhile before giving up the "facile truism" of natural selection.

(1) Prof. Poulton did *not* "quote *in extenso* a letter from Darwin to the distinguished American botanist Asa Grey", but two short extracts from the concluding chapter of "The Variation of Animals and Plants under Domestication" which had accompanied it (NATURE, June 8, p. 874). For Prof. MacBride to have been "well acquainted" with the substance of those quotations before writing his first letter (NATURE, May 11, p. 712), he must have read it, and with some attention, in the original, where it occupies nearly a page in Chap. xxi. and more than a page in Chap. xxviii. Inadvertence is no crime, but it is worth noting that Prof. MacBride does not always verify his references, and is liable to lapses both of memory and of pen.

(2) Natural selection, it will be remembered, was compared by Darwin to a man building an edifice, not of cut stones, but by selection from the varied fragments of rock at the base of a precipice. Prof. MacBride terms Darwin's analogy "false" and his reasoning "thoroughly bad"—false, because Darwin's organic variations were fortuitous, while the variations of stones are "definite", as may be seen by comparing a scree of Harlech grits with one of Llanberis slates. Having a critical mind, Prof. MacBride will at once recognise his mistake in this illustration. Darwin's metaphor dealt with the stones beneath one precipice, not two; and in any one scree, as Prof. MacBride noted, the stones are mostly of one type, with the characters due to fracture from one kind of rock,—grit or slate, say, but not both together. The variation in the shapes and sizes of the stones is thus homotypic and fortuitous, and obeys the laws of chance, as Darwin assumed. Prof. MacBride's illustration would be valid only in a comparison between the variations of two different types of animals, say herrings and sea-urchins; but Darwin was illustrating an act of evolution, which involves only the variation of one type.

(3) Darwin's analogy is also falsified, according to Prof. MacBride, by another discrepancy, since house-building involves "psychic factors" ("purpose", "end", "ideal"), whereas his theory of evolution did not. All metaphors, of course, have their limits of application, but in this case the objection is groundless, since Darwin only used his metaphor to illustrate the relations of selection to the raw materials of variation. From his point of view the psychic outfit of the builder could be ignored. The building operations of an arenicolous foraminifer or of a caddis worm would have suited him almost as well but for their relative unfamiliarity (cf. the simpler version in Chap. xxi. of "Animals and Plants").

(4) "Natural selection", says Prof. MacBride, merely means "the survivors survive" (loc. cit., May 11): the idea of a differential death-rate, which discriminates between the possessors of different "variations", is "definitely not true". To obtain this result, however, it is first of all desirable to rule out of consideration all "ill-adapted types" as belonging "not to the *natural*, but to the *pathological*" (Aug. 10). The new philosophy, it thus seems, is frankly Procrustean.

(5) Yet, in spite of all this, Prof. MacBride goes on to say, "natural selection is a reality". He is convinced of its reality because for seventeen years he has "raised annually thousands of larvæ of the same species". Presumably he has witnessed a heavy mortality in his pots. "But what is 'selected'", he says, "is not the 'random' variation, but . . . 'the most plastic individual', that is, the one which reacts best to the environment; in other words, *the most vigorous*." Prof. MacBride has been severe with others for their "unsupported assumptions", but who can tell what a torrent of pungent epithets he would have poured over this remarkable passage if he had found it in the writings of Darwin, Poulton, or any other prominent advocate of Darwinian selection? There is just the possibility, however, that it is an elaborate joke, and means: "Even under the superlative conditions of my own rearing jars, natural selection insists on remaining a truism." If, on the other hand, it is to be taken seriously, one may perhaps ask Prof. MacBride how he knows that the survivors were the "most plastic" individuals, which reacted best to the environment. A word or two also on the nature of the 'reactions' would be welcome.

(6) Prof. MacBride characterises the mental attitude of Darwin and his family towards natural selection as an example of the error due to the "reification of words". After his latest pronouncement it seems just a little doubtful whether the "verbification of things" really offers the prospect of a more fruitful gospel.

WALTER GARSTANG.

Leeds, Aug. 24.

Nature of the Rickets-producing Factor in Cereals.

WE have become used to the idea that rickets is a vitamin deficiency condition, and yet there are several facts which militate strongly against complete acceptance of this hypothesis. The most important consideration is the fact that rickets can be produced experimentally by feeding with excess of cereals. It will be remembered that before the demonstration that rickets could be induced in puppies by a diet devoid of what we know now to be vitamin D, one theory of the etiology of rickets in infants attributed the disease to the well-known excessive carbohydrate (or, to be more accurate, cereal) intake of the children.

E. Mellanby, Holst, and Green and Mellanby have followed up this interesting observation, and their recent investigations have shown even more conclusively that typical rickets can be induced in growing puppies and rats by feeding with excess of cereals, or by adding extracts of cereals to a diet which does not produce rickets in control animals. The cereal employed was mostly oatmeal, but wheatmeal, rice, barley, maize, white flour, wholemeal flour, and peas were also found to have the same anti-calcifying effect, although not to the same extent.

As to the nature of the substance that is responsible for this effect, there has been much speculation. It is not the contained starch or the salts, and it had been concluded that it is an 'anti-vitamin' present in small amounts in the cereals, thermostable, dialysable, but destroyed by prolonged boiling with acid. The great stumbling-block to investigation has been the mechanical difficulty of the extraction of the cereals.

In my experiments I first evolved a simplified method of extraction. In short, the process consists of boiling the oatmeal with one per cent hydrochloric acid for some hours, then evaporating the solution to a small bulk, and dialysing against distilled water; the dialysate is evaporated to dryness and then extracted with 95 per cent alcohol; the alcohol is evaporated off and the final residue is dissolved in water and is ready for injection into animals. I then set out to investigate what action the cereal extract has on the blood calcium level. After prolonged investigation, I am able to report that cereals—or at least oatmeal, as most of my work was done on oatmeal—contain a substance which when injected into

rabbits lowers the blood calcium. The character of the response of the blood calcium level is the same as I previously found to be the case for extracts of bovine ovaries, namely, a lowering of blood calcium of about 30-35 per cent usually in twenty-four hours and a return to normal in about forty-eight hours. In all respects the type of response was exactly the same as that recorded in the case of ovarian extract.

It would thus appear that the substance which has the anti-calcifying action has the same action on the blood calcium as the ovary. One can therefore assume that the mode of action of this 'anti-vitamin' is simply by reducing the blood calcium; hence the observations of previous investigators that this action of cereals can be counteracted quantitatively by administering either calcium salts or vitamin D, both of which act by raising the blood calcium. From the work of Robison and his associates we know that the bone enzyme or phosphoric esterase occurring in ossifying bone is quite adequate in rickety bone, but faulty ossification in rickets is apparently due to insufficient concentration of calcium or phosphorus or both in the blood.

The implications of this finding are many and varied and are fully discussed in the paper appearing shortly, which contains a full report of this work. The most important result is that rickets cannot be conceived to be purely a vitamin deficiency condition, but is primarily and ultimately due to a lowering of the blood calcium. This lowering of the blood calcium (and a low blood phosphorus is most probably secondary to it) can be produced by lack of vitamin D, by the administration of cereals, or by a faulty calcium to phosphorus ratio in the diet. Actually, rickets may yet prove to be a manifestation of hypoparathyroidism in young growing animals. If that is the case, our present conception of the rôle of vitamin D and probably of the other vitamins will have to change very appreciably.

L. MIRVISH.

Department of Physiology,
Medical School,
University of Cape Town,
July 18.

Vitamin B.

IN recent work Dr. Vera Reader (*J. Soc. Chem. Ind.*, **47**, 1247; 1928) has found that at least two thermolabile vitamin B factors are necessary for the nutrition of the rat, in addition to the factor or factors supplied by alkaline autoclaved marmite. Proof of these three 'B' factors has been made possible by the use of concentrates prepared from baker's yeast by the extended method of Kinnersley and Peters (*Bioch. J.*, **22**, 419; 1927), in which the process was carried through to the alcohol stage. These concentrates contain B.1, and are highly curative to the pigeon, but when given to rats in large amounts (up to 8 pigeon doses per diem), they do not supplement completely alkaline autoclaved marmite (pH = 9·0 for 1 hour at 120° C.). The latter contains the thermostable so-called anti-pellagra factor. These facts dispose of any objections raised in a recent paper (Aykroyd and Roscoe, *Bioch. J.*, **23**, 493).

The three factors in question are present in fresh marmite. I have found that fresh marmite in the presence of casein and cod liver oil does not lead to resumption of maximum weight in adult pigeons fed upon polished rice. As I have confirmed the finding of Williams and Waterman (*J. Biol. Chem.*, **78**, 311; 1928), that increase to a maximum weight readily takes place upon a whole wheat diet, the factor discovered by Dr. Reader is not the same as the thermolabile factor of Williams and Waterman. In so far as it is thermolabile, it would also appear to differ from that of Hunt (*J. Biol. Chem.*, **79**, 723; 1928).

I am directing attention to these facts here because of their importance to workers in this field. It should be realised that *at least* five 'B' factors have now been described: (1) the original thermolabile, anti-neuritic, curative to pigeons; (2) a second thermolabile (V. Reader); (3) a thermostable factor present in alkaline autoclaved marmite (anti-pellagra, Goldberger, etc.); (4) a second thermostable factor described by Hunt; together with (5) the 'Williams and Waterman' factor. The importance of the latter has at present been demonstrated only in pigeons. According to the exact conditions of the tests, some of these factors must have been included as either B.1 or B.2 in much of the previous work.

RUDOLPH A. PETERS.

Department of Biochemistry,
Oxford, July 29.

Adsorption of Water by Wool.

IN the current number of the *Transactions* of the Faraday Society (**25**, 451; 1929), Mr. A. T. King discusses the changes produced by stretching in the hygroscopic capacity of single wool fibres. Although of a different nature and carried out for a different purpose, the following independent experiments seem to provide an answer to some of the inquiries raised by Mr. King's paper.

I have shown in previous papers that when wool fibres are held stretched in water, the fibrillæ within the cells undergo plastic flow and take a permanent set. It seemed probable that the affinity of the fibrillar structure for water would be increased by the disorganisation of its crystal structure and the question was examined in the following manner. Two consecutive 5-centimetre lengths were cut from a single wool fibre, one of these being kept stretched 30 per cent of its length in water at 25° C. for twenty-four hours, so as to occasion the maximum possible plastic flow of the fibrillar structure. At the end of this time the fibre was released and allowed to return to its original length. The other 5-centimetre length of fibre was simply immersed in water at 25° C. for twenty-four hours without stretching. A sufficient number of fibres were treated in this way to provide ultimately about 30 milligrams of both types of material. I have shown that no rupture of fibrillæ occurs in single wool fibres if these are not stretched beyond 30 per cent of their length, so that the only difference between the two samples was that in one case the fibrillæ had undergone plastic flow, whereas in the other case they remained completely unaltered.

The amounts of water adsorbed by the two samples were determined at a number of different humidities

Relative Humidity (per cent).	Percentage of Water adsorbed by:	
	Untreated Wool.	Stretched Wool.
63·3	14·31	14·44
92·5	24·92	25·77
100·0	..	..
75·0	17·92	18·95
34·2	9·53	10·24

by suspending them from a quartz spiral balance over sulphuric acid solutions of the required strength in a constant temperature room (22·2° C.). Each sample was taken from absolute dryness up to saturation in stages, and then in the reverse order to dryness, so that the values given in the accompanying table correspond

with true adsorption and desorption processes. The amount of water adsorbed at 100 per cent relative humidity is not indicated because of the difficulty in preventing actual condensation of water on the wool. In every instance the amount of water adsorbed by the wool which had been stretched was greater than that adsorbed by the untreated sample, and it seems clear that plastic flow in the fibrillar structure alone will increase the affinity of wool for water.

J. B. SPEAKMAN.

The University,
Leeds,
Aug. 14.

The Adsorption of Organic Acids by Charcoal.

IN the recent issue of the *Proceedings of the Royal Society* (A, **124**, 554; 1929), H. J. Phelps and R. A. Peters, while studying the adsorption of some organic acids on pure charcoal as a function of the hydrogen ion concentration, come to the conclusion that, in the given conditions, the non-dissociated molecules and not the corresponding anions are adsorbed. This conclusion is based on similar observations to those already made by R. Wurmser and myself some years ago (*C.R.*, **179**, 972; 1924) with another charcoal, that, while for different acids there is no relation between adsorption and dissociation, in the case of the same acid, there is a very definite relation between these two phenomena; and I am very glad to see our results confirmed and enlarged by the interesting work of Messrs. Phelps and Peters.

May I now recall that, in another communication published in the same year (*C.R.*, **179**, 1404; 1924), which seems to have escaped the attention of the authors, I was able to give a definite proof of the selective adsorption of non-dissociated molecules by the charcoal used. Having previously determined (spectrographically) the sum *molecules + possible anions* adsorbed, I measured the electrical charge acquired by the charcoal particles after adsorption, and found it completely independent of the quantity and of the nature of the adsorbed acid, the data being of course reduced to the same hydrogen ion concentration. It seems, therefore, that this is the best proof of the electrical neutrality of the adsorbed substance.

It is easy to see that this result, of course, does not exclude the possibility of electric forces playing a rôle in that type of adsorption phenomena, when one recalls that the molecules adsorbed here are dipoles which are liable to be affected by electrostatic forces (cf. V. Henri, "Structure des molécules").

CLAUDE FROMAGEOT.

Kaiser Wilhelm Institut für Biochemie,
Berlin-Dahlem.

Anomalous Diamagnetism.

IN a letter in NATURE of June 22 (p. 945), reference was made to the Ehrenfest hypothesis which ascribes the high diamagnetic susceptibility of bismuth to the existence of closed electron orbits of larger than atomic dimensions in association with the crystal lattice.

It may be pointed out that the existence of such orbits appears to furnish a very natural explanation of a variety of phenomena which up to now have been obscure. In the first place, the extremely pronounced diamagnetic anisotropy characteristic of bismuth (and also of graphite) becomes immediately intelligible as a consequence of the specific orientation of the assumed electronic circulations within the crystal lattice. Further, the large Hall effects and changes of electrical resistance exhibited by bismuth and graphite when placed in a magnetic field become comprehensible, since the electronic circulations would be modified by the field, and result in corresponding modifications of the flow of electricity through the substance under a simultaneously impressed electromotive force. There would be every reason to expect, as is indeed the case, that the magnitudes of the Hall effect and the change of resistance would depend on the orientation of the crystal in the magnetic field and the direction of flow of electricity through it.

Then again, with rise of temperature and consequent thermal derangements of the lattice, the postulated electronic circulations would tend to disappear and give place to chaotic electronic movements. The diamagnetic susceptibility would then diminish towards its normal value for a non-crystalline condition of the substance, and corresponding changes would occur in the coefficients of the Hall effect and magnetic variation of electrical resistance. That liquid metals do not, so far as I am aware, exhibit a measurable Hall effect is significant in this connexion.

In close analogy with the influence of temperature, and presumably to be explained on very similar lines, is the remarkable fact that the anomalous diamagnetism of bismuth and of graphite tends to diminish or disappear when the substances are reduced to a colloidal condition.

Finally, it may be remarked that the dimensions of the crystal lattice cannot be uninfluenced by the existence of such regular electronic circulations within it or by modifications produced in them by an external agency. That the magnetostriction of bismuth in strong fields discovered by Dr. Kapitza (NATURE, July 13, p. 53) is connected with the anomalous diamagnetism of the substance admits of little doubt. The notable increase in magnetostriction at low temperatures observed by him appears to fit in very well with the Ehrenfest hypothesis.

C. V. RAMAN.

Dew: Does it Rise or Fall?

MESSRS. E. E. Free and Travis Hoke begin Chapter xiii. of their recent work on "Weather" (Constable and Co., 1929) by stating that "the chief thing to be said about dew is that it doesn't fall, early or late, on Maxwelton or any other braes. In fact it rises." They go on to explain that dew is formed when the warm, moist "breath of the ground" comes in contact with colder objects, such as leaves, twigs, or spider webs, causing precipitation. They make no note of the fact that dew is formed only under a clear sky which allows free radiation of the earth's surface heat; but they make the following surprising statement: "Most of the dewdrops on leaves and blades of grass, especially leaves close to the ground, are on the under sides; that is, the side of the leaf or grass closest to the soil."

This was so widely at variance with the general impression I had received, that I went out on three dewy mornings to examine the herbage, and found, as I expected, that while the upper surfaces of leaves were heavily bedewed, the under surfaces were quite dry.

In stating that dew does not fall, but rises, the authors seem to be treating of dew before it is formed. It is true that the warm air radiated from the earth is charged with moisture, but that continues as vapour until it meets the cold night or morning air, when it is condensed and precipitated as dew. The vapour rises, but the dew can only be described as falling.

HERBERT MAXWELL.

Monreith.

Early Man in East Africa.

IT was inevitable that problems relating to early man and his culture should count largely in the proceedings of Section H (Anthropology) at the South Africa meeting of the British Association. Not only had the study made great strides locally since the Association last met there in 1905. Recent discoveries such as that of Rhodesian man and the Taungs skull had aroused intense interest which was bound to find expression. The meeting afforded European archæologists a unique opportunity to acquire first-hand knowledge of local conditions and to discuss them on the spot. In addition, the presence in Johannesburg of a number of visitors to the International Geological Congress made it possible to bring together a body of expert opinion on points depending upon geological evidence in conditions which it was improbable would recur.

Among the more important of the topics which had been announced for discussion was that of early man in East Africa, Mr. L. S. B. Leakey having undertaken to report upon the work of the East African Archæological Expedition in 1926–27 and 1928–29. It will be remembered that a preliminary report on the earlier season's work was presented to Section H of the British Association at the meeting in 1927. The work of the second season has confirmed, but at the same time has extended, the tentative conclusions based upon the earlier investigations in such a way as to necessitate a certain amount of revision in terminology and correlation. (A note of this revision appeared in a letter from Mr. Leakey and Mr. J. D. Solomon, geologist of the expedition, which was published in NATURE of July 6, p. 9.)

At the close of operations in 1927, three pluvial phases and one post-pluvial wet phase had been recognised, the latter connected with the 185 feet beach of Lake Nakuru, and Stone Age industries had been found associated with the second and third pluvial phases. Human remains were associated with the third phase, to which the name of 'Elmenteita man' had been given, and also with the post-pluvial wet phase of Nakuru. By the work of the second season, a still earlier pluvial phase, a number of earlier cultures and more human remains were revealed. Further, a gap in evidence was filled by the discovery of large collections of animal remains.

On the basis of these results, suggestions have been put forward as to their age, and a tentative correlation of the pluvial phases with the glaciations of Europe has been made. If this should be confirmed, it will establish a direct time relationship between the European and Central African Stone Age cultures.

The work of the Expedition has centred mainly around the chain of lakes which lie on the floor of the eastern branch of the Great Rift Valley from Lake Baringo in the north to Lake Magadi in the south, the central area round Lakes Nakuru, Elmenteita, and Naivasha being worked out in greatest detail. These lakes, now shrinking rapidly, in former times have been of considerable size and depth, as shown by the old lake beaches. They bear evidence of considerable climatic changes in times stretching back to the Pleistocene or possibly to the Pliocene.

As a result of fresh evidence, the nomenclature now suggested is as follows :

Old Name.	*New Name.*
Post-Pluvial wet	Nakuran. Makalian.
Third Pluvial	Gamblian.
Second Pluvial	Enderian.
First Pluvial	Eburrian.

The old first and second pluvials are considered minor phases of the same event, not separated by a period of aridity, but merely by a break in the pluvial conditions of the Enderian. The Eburrian corresponds to Prof. J. W. Gregory's Kamasia Sea, which that authority attributed to the Miocene, a view which Mr. Leakey does not accept owing to the occurrence in it of an Acheulean culture.

An association of cultures with these phases has been worked out. It is to be noted that Mr. Leakey employs a European terminology in preference to a localised nomenclature, but he puts in a caveat that, though based upon resemblance, no implication of contemporaneity is made thereby. It has to be borne in mind that the Kenyan cultures, owing to a difference of material, present variations which do not appear in the European cultures. With this reservation, the culture and pluvial sequences are associated as follows :—

Pluvials.	*Cultures.*
Nakuran	Kenyan Wilton. Nakuran.
Makalian	Elmenteitan.
(Late Gamblian)	Red-bed culture. (Mousterian influenced by Aurignacian.)
Gamblian	Upper Kenyan Mousterian. Upper Kenyan Aurignacian.
Enderian	Lower Kenyan Mousterian. Lower Kenyan Aurignacian.
Eburrian	Kenyan Acheulean.

In regard to this classification, it is to be noted that both Mousterian and Aurignacian occur at the base of the Enderian deposits, although only a very small series of Aurignacian types has been found. Right through the sequence the two co-exist side by side, but there is no sign of any fusion until the closing stage of the Gamblian in the Red-bed culture. This has close affinities with the Bambata culture of Southern Rhodesia and the Still Bay of South Africa. The most strongly developed Aurignacian is found in the lowest deposits of Gambles Cave II, the chief tools being backed blades of Chatelperron and Gravette type, burins and end- and keel-scrapers. The Elmenteitan is a localised development of the Upper

Kenyan Aurignacian without exact parallel in Europe, but with close affinities to Magdalenian. With it is associated a very fine pottery. The Nakuran is a culture contemporary with and closely allied to the Kenyan Wilton, so called from its resemblance to the Wilton industry of Southern Rhodesia. With it are stone bowls, pestles and mortars, and other evidences of agriculture, hut circles of stone without mortar, and a few beads of agate and faience said to resemble beads of Mesopotamia and pre-dynastic Egypt.

Fragmentary human remains and two whole skeletons have been found in Gambles Cave II associated with the Aurignacian culture. Unquestionably *Homo sapiens* and non-negroid, they show certain resemblances to the Elmenteita type which followed and was probably descended from them. The Elmenteita type, found in association with Elmenteita culture in 1927, is also non-negroid, though one skull, a female, shows definite negroid tendencies. On a Wilton site at Willey's Kopje, though not of proven makers of Wilton, were a number of skeletons of long-limbed negro type, but with several features distinguishing them from any modern negro series. The only complete skull from Nakuru is on the whole non-negroid, yet it has certain negroid characters. In certain respects it is said to recall skulls from Al-Ubeid, near Ur.

The fauna have not yet been worked out, but they include an extinct horse of Enderian date and an extinct water buffalo of Gamblian date. Dr. E. Reck, of Oldoway, considers the Enderian fauna equal to the Oldoway fauna, in which 50 per cent were extinct species, and associated with them was a skeleton of *Homo sapiens* almost certainly of the same race as Mr. Leakey's Gambles II.

As regards the correlation of the pluvial periods with the European time sequence, there is a strong probability that the glacial phases of Europe must have resulted in an increased rainfall in regions to the south. This may account for the pluvials of Kenya. It is therefore suggested that the Makalian should be compared with the Buhl Stadium and that the two major pluvial events should be correlated with the glaciations of Riss and Würm. However that may be, local evidence, such as the fact that the Eburrian series are faulted by the second main series of the Rift Valley faults, and that the Enderian series have yielded pleistocene animals, affords good grounds for considering the two main pluvials as Pleistocene events, possibly with the beginning of the first major pluvial in the Pliocene, the minor pluvial (Makalian), being at the close of the Pleistocene and beginning of the Holocene. Thus both Mousterian and Aurignacian can be considered as arriving in Kenya at the beginning of the second half of the Pleistocene.

It will not be out of place to refer at this point to a paper presented to Section H at Johannesburg on July 31, by Mr. C. van Riet Lowe, on the archæology of Sheppard Island and the Vaal Valley generally. Mr. Lowe's investigations have established three, and probably four, pluviations in South Africa, with three of which different palæolithic cultures are associated. In the First Pluvial, man practised a Lower Stellenbosch (true Chellean type) culture, as found in terraces 30-100 feet above present river level. In the Second Pluvial is Upper Stellenbosch (that is, Acheulean type) side by side with mammoth and *Archidiskodon Sheppardi* and *Archidiskodon Transvaalensis*. In superimposed lighter gravels are the remains of Fauresmith (La Micoque type) industry mixed with remains of Middle Stone Age of a distinct Mousterian flavour—the earliest arrival of the Mousterian which ultimately gave rise to pure Middle Stone Age industries practised throughout the country. Belonging to the lighter gravels are two extinct species, *Equus Capensis* and *Bubalus Bainii*—this latter the extinct water-buffalo found by Mr. Leakey in Kenya. A period of extreme aridity of considerable length preceded the Third Pluvial, in which appear folk of a true Neoanthropic type practising the industries of a Later Stone Age with marked Capsian-Aurignacian flavours. These overlie a heavy stratum of silt which covers the Middle and Earlier Stone Age remains. This deposit, which represents the most recent terrace of this type in the Vaal Valley, is most probably Pleistocene. Mr. Lowe, while holding it reasonably probable that these pluvials might be correlated with European glaciations, did not consider the time yet ripe for anything more than the most tentative of suggestions.

It is scarcely necessary to emphasise the significance of Mr. Lowe's contribution to the problem of early man in Africa in relation to Mr. Leakey's investigations. It must be evident that a great deal more investigation and reflection on the evidence already at hand is necessary before any conclusion can be formulated. That we have not yet attained any crucial evidence as to the place of origin of man's early cultures is obvious; yet, as always, it seems to point to the north, possibly to somewhere in the Saharan area, at this period not yet arid. In *Man* for July, Mr. Wayland of Uganda, who unfortunately was prevented by illness from taking any part in the discussions, inculcated caution in drawing conclusions from the Kenya evidence, and, while suggesting a rather later date than had previously been claimed for Nakuru man, looked tentatively to Miss Caton-Thompson's Fayum neolithic for a possibly contemporary, possibly even older culture.

The whole question, as was to be expected, gave rise to considerable discussion, and a committee appointed *ad hoc* held two sessions in which it was discussed and questions of terminology thrashed out. Of this no doubt more will be heard later. Some of the members have had the additional advantage that on their return they have visited Kenya and inspected the sites on which Mr. Leakey has worked. In a cable from the *Times* correspondent at Nairobi, published on Sept. 3, it is stated that Prof. H. J. Fleure has confirmed the conclusions as to the succession of deposits and agreed that the human remains are different from those of any of the modern population, while holding that the succession of cultures affords an extraordinary parallel with those of the Old Stone Age in Europe.

Science and Engineering.[1]

By Prof. F. C. LEA.

THE economic and beneficent importance of the work of the engineer is recognised by all, in the provision of safe, reliable, and efficient means of transport and in the wonderful harbours and docks which make possible the interchange of commodities between the nations; in the utilisation of sources of energy for doing the work of the world; in the equipment of factories and workshops with machines that produce abundantly so that the standard of life is raised; in supplying to communities pure water and in the disposal of sewage without danger to health or to the contamination of rivers and streams; in making it possible to plough the great spaces and gather the abundant harvests with little labour; in the provision of implements to combat the enemies of the fruit harvest and in the construction of dams and reservoirs to store the abundant rains for the time of drought so that even the barren places shall be fruitful and rejoice. For these achievements of engineering it is not difficult to obtain recognition, but it is often overlooked that engineering is affecting the intellectual outlook of peoples and by its very successes may introduce social and political problems of great significance.

It is not, however, desired in this address to emphasise the intellectual or political influences of engineering but rather to suggest: (1) the vital importance of scientific research to engineering; (2) that as in the remarkable engineering developments of the last century the scientific method has been the key to progress, even so it must be in the future; and (3) that there are many engineering problems of great interest and importance, not only to engineers but also to the general public, which can only be solved by supplementing experience by direct and indirect attack, using all the aids that mathematical and experimental science can give. It is also desired to suggest that all the arguments for a public interest in scientific research apply with particular force to the subject of engineering.

[To illustrate these three aspects of his subject, Prof. Lea touched upon many branches of engineering and scientific inquiry, ranging from ancient engineering as seen in Mesopotamia, Egypt, and Rome, to the pregnant researches of Carnot, Clausius, Froude, Reynolds, Rayleigh, Maxwell, Hertz, Fleming, Coker, Eddington, Einstein, Michelson, and Morley. "Upon almost every section of this Association", he said, "engineering lays tribute, and in return engineering has given something at least to make possible much of the brilliant work associated with other sections". Only the precision of modern engineering has made possible the manufacture and control of great telescopes and other instruments by which the predictions of Einstein could be tested.

In the main, however, Prof. Lea kept to the important matters of prime movers, structures, aeroplanes and airships, materials and roads, all of which afford abundant testimony to the interdependence of engineering and abstract science. There were great bridges in ancient times, but such structures as the Forth Bridge, the Sydney Harbour Bridge, the Zambezi Bridge, and the Hudson River Bridge of 3500 ft. span, now in course of construction, were not possible before the birth of modern science and the scientific method. Neither was there a useful steam engine or other great and efficient prime mover before there came into the intellectual life of Europe that wonderful renaissance out of which modern experimental science was born.

Before Savery and Newcomen produced the first successful steam engine, many experiments on the pressure of the atmosphere, the relation between pressure and volume in gases and on the condensation of steam, had been made by Porta, Torricelli, Papin, Boyle and others. Watt's great improvement of the steam engine was surely not an invention in the ordinary sense, but a splendid deduction from the quantitative knowledge of the latent heat of steam obtained from his own experiments and those of Black. In the latter part of the eighteenth century and the beginning of the nineteenth, organised experiments on the flow of fluids were carried out, relative velocities, momentum, and kinetic energy were well understood, and the next step was made by Poncelet in 1832, who enunciated the guiding principles underlying the design of vanes receiving moving fluids, and from that time progress has been so remarkable that to-day water turbines of more than 70,000 h.p., having efficiencies greater than 80 per cent, are being constructed. The brilliant achievements in the development of the steam turbine of Sir Charles Parsons and others following in his steps are to-day well known.

At the beginning of the nineteenth century there were probably 10,000 engines in England, giving a total horse-power of about 200,000. To-day, steam turbines, each capable of developing 200,000 h.p., have been or are being made for stations in various parts of the world. It seems very doubtful if this could have been possible except as a consequence of the work of Poncelet and two centuries of scientific experiment.]

PRIME MOVERS.

Though so much has been done in the development of prime movers, there is perhaps no movement in engineering to-day that is of greater interest, not only to engineers but also to the general community, than the attempts that are being made to increase considerably the efficiency of power production from coal and other fuels. The average overall thermodynamic efficiency of the public stations distributing electrical energy in Great Britain for the year ending March 1928 was about 15 per cent. The best station had an efficiency of 21·3 per cent. Recently a power unit has been supplied from England to Chicago which on test gave an efficiency of 34 per cent—a remarkable figure. Making allowance for boiler losses, efficiencies of from 25 to 35 per cent ought to be possible, therefore, in the future, and if only suitable materials can be developed to meet the onerous conditions of temperature, corrosion, and erosion, higher efficiencies than 35 per cent may be anticipated with steam plant. Still higher thermodynamic efficiencies may be expected, as

[1] From the presidential address to Section G (Engineering) of the British Association, delivered at Johannesburg on Aug. 1.

well as the chemical riches of the coals preserved, if, as a result of research, solid fuel engines or gas turbines can be developed.

At the temperature of from 400° F. (205° C.) to 600° F. (315° C.) at which boilers and super-heaters have until recently worked, mild steels have been found suitable. To realise higher efficiencies than at present, much higher temperatures will be required, and at contemplated temperatures of 1000° F. (538° C.) and upwards carbon steels creep at low stresses. Below a certain stress, at a particular temperature, which I have ventured to call 'the limiting creep stress', the creep ceases or becomes so small that it cannot be observed in, say, a number of days. This 'limiting creep stress' is evidently the important factor in the problem of high working temperatures. Experiments indicate that, with alloy steels, limiting creep stresses much higher than those obtained from carbon steels may be expected, and that alloys of iron, nickel, chromium, and with or without other alloyed elements, containing so much as 60 per cent of nickel and chromium, have considerable strength at high temperatures and also resist corrosion and erosion. There is still, however, a very large amount of research to be done in which the laboratory and the workshop must co-operate; as new workshop technique is required before these alloys can be used for specific purposes.

Structures.

The indebtedness of structural engineering to mathematics and to experimental science has already been suggested, but these powerful aids to progress had to be supplemented by the development of new materials and by a direct experimental attack before the remarkable achievements of recent times were possible.

In this respect it is well to go back occasionally to William Fairbairn, president of Section G of the British Association in 1862. He carried out his classical experiments during the forties of last century to determine stable forms of compression elements for structures, and upon his experiments practice followed rather slavishly for more than forty years. The failure during erection of the cantilever of the Quebec Bridge dramatically forced attention upon the problem of the stability of compression elements. Again a series of experiments filled the gap in knowledge and led to success.

Further work on a large scale, the cost of which can probably only be undertaken by public authorities, is desirable. During the last twelve years attempts have been made, with considerable success, to design all-metal aeroplanes and rigid airships, the compression elements and beams of which must of necessity be as light as possible. With a fair degree of precision the external forces can be determined by experiments upon models. The structure of an aeroplane has a certain degree of 'statical indeterminateness', but the forces and the bending moments in the elements can be approximately obtained, and what might be called the primary stresses can be found with the same degree of approximation.

Three serious difficulties, however, immediately faced the designers: (1) materials of a suitable character and in a suitable form for constructing the very light but strong elements; (2) the lack of technical skill and suitable machinery for building up the elements; (3) the lack of knowledge and the almost insuperable difficulty of determining by analytical methods the secondary, and what might be called stresses of even higher orders of indeterminateness. The only way was a courageous combination of experiment and mathematical investigation. One without the other was useless, but by a combination of the two rapid progress was made, and to-day all-metal aeroplanes are being constructed of steel or of duralumin which are as light, more durable, and stronger than the aeroplanes made of the best spruce.

There is still, however, a great deal to be done in connexion with structures, and the only hope of a satisfactory solution of many problems is not simply by accumulating experience, but by combining experience, experiment, and mathematical analysis in an endeavour to reduce the whole to definitely co-ordinated knowledge. Nearly thirty years ago I was privileged to assist with some experimental inquiries on the deflection of bridges produced by rapidly moving loads. They were incomplete, but they definitely indicated that the assumptions often made by engineers as to the effect of rapidly moving loads were not justified. In view of the publication in the early part of this year of the report of the Bridge Stress Committee, published by the Department of Scientific and Industrial Research, of which perhaps it is only necessary to say that it is worthy of its distinguished chairman, Sir Alfred Ewing, and his colleagues, it is fitting to refer particularly to this subject of impact on bridges.

So early as 1849, in the Report of the Royal Commission on the use of wrought iron in railway bridges, the subject was discussed, and Sir George Stokes gave a mathematical solution for a load moving over a girder, but this solution was of little value in practice. For eighty years the effect of travelling loads has been treated in an empirical, illogical manner and a number of impact formulæ, which the Bridge Stress Committee Report shows have no valid foundation, have been used rather blindly by engineers. The report shows very clearly that what is important is not the fact that the load is applied suddenly to the structure, but the possibility of synchronism or otherwise of the structure with the periodicity of unbalanced forces due to the engine or to other causes. Experimental data of the vibrations produced in the structure by the various types of moving loads have been carefully obtained and methods of analyses developed which have made it possible to determine with some degree of precision the true impact factors to be applied.

Thus a problem of real difficulty, in connexion with which doubt and uncertainty has probably led to expenditure far greater than the necessities of the case demand, comes within the possibilities of solution. The carefully conducted work of the

Committee spread over a few years has given more precise guidance for future designers than a hundred years of practice.

AEROPLANES AND AIRSHIPS.

The development of the forms of aeroplanes and rigid airships and the determination of the forces acting upon them—lift and drag—and the distribution of these forces, is another illustration of the splendid use that can be made of the combination of experiment and mathematical analysis. Following the fundamental principles of Newtonian mechanics, dynamical laws of similarity have been developed which, in combination with the wind chambers and the precise measuring devices used for the determination of forces and moments acting upon models, have made it possible to anticipate certain of the forces acting upon machines. Other forces could only be estimated from meteorological data obtained from an examination of the velocity and upward and downward currents of air which a ship or aeroplane may suddenly encounter.

Much could be said of the many other contributions of ' pure science ' to the successful development of the aeroplane. Many of the details and instrumental equipment owe much to science, but success could not have been achieved if these gifts had not been supplemented by the application of the experimental method, in which precise measurement has played an important part, to the solution of the specific engineering problems associated with the engine and the structure.

MATERIALS.

Allied to the subject of structures is that of the strength of materials and their behaviour under various types of stress. For nearly seventy years experiments have been carried out to determine the effect of repeated stresses on metals, but the development of high-speed machinery during the last twenty years has focused attention upon this important subject, and it is now realised how imperfect is our knowledge.

A vast amount of experimental data has been accumulated, and it has been clearly shown that the safe range of stress to which a piece of material can be subjected for, let us say, an indefinite number of times, depends in some way, not yet clearly defined, upon other and more easily determined physical properties. But it is not yet always possible to foretell that some element of a locomotive or of an aeroplane engine, or structure, or other machine will not fail under the conditions it has to meet in practice. Small discontinuities in the structure of wheel tyres, a surface defect in an axle, a wheel gripping very tightly on an axle at one section, surface cracks which cannot even be seen by the microscope on a wire used for a rope, or in the disc of a steam turbine rotor ; the surface condition of a quenched and tempered spring used for a locomotive, an aeroplane engine, or a motor-car, may lead to failure under the repeated stresses due to the normal forces acting upon the element, or due to repeated blows, such as, for example, a locomotive experiences whenever it passes over a rail joint, or a motor-car along a road. Cam-shafts for the stamping mills used in the gold mines frequently fail, and engineers and metallurgists are often at a loss to give a reasonable explanation. The whole problem is bound up, not only with the physical properties which statical experiments are capable of testing, but apparently in some unknown way with the nature of the crystal structure of a metal.

ROADS.

Before concluding, I should like to refer to another subject of interest. The rapid developments of road traffic during the last quarter of a century has made the road problem one of considerable importance. From the point of view of the user and the community, the general policy of road construction, the capital expenditure involved, and the cost of upkeep are of primary concern. These are dependent upon the materials available and the use made of them. Incidental to the problem is that of vibrations produced in structures adjoining the road and the probable damage accruing from them, but of this there is only time to say that experiment is necessary to determine the importance of these vibrations on the materials of structures.

Reference has already been made to the lack of knowledge of the effect of blows and stresses due to vibrations in causing failure in metals, and the lack of precise knowledge which will make it possible to choose with assurance the particular material to meet certain circumstances. The problem of road surfaces is in a large measure one not only of the suitability of materials to resist impacts but also of the prevention of impacts.

Many experiments of actual road surfaces are being carried out in all parts of the civilised world, but considering its economic importance, the cost of upkeep of roads and the inconvenience of repeated repairs, it would appear that it would be well worth while, even though there may be doubt as to whether any definite and final conclusions can be reached in the laboratory, to let carefully but boldly conceived laboratory experiments direct the large-scale experiments much more than at present. If the history of other engineering developments is to repeat itself, only by such a procedure is the solution likely to be found.

There is another aspect of the subject which is perhaps related more to economics than to engineering, but it nevertheless demands a definite scientific approach, rather than a policy of drift. I refer to what has almost become a contest between road and railway development. At home there seems no doubt that thousands of tons of heavy materials are carried upon roads, with some element of convenience, it is true, that should be carried on rails, at much greater gross cost to the community than if sent by rail. The calorific value of the fuel consumed per ton mile and consumption of other materials is greater for road than for rail transport, and the actual damage done to road surfaces and vehicles is much greater for the heavy loaded road vehicles than for rail vehicles. True it is that flexibility, direct delivery, and many other

advantages are claimed for road traffic which may far outweigh the disadvantages just referred to, but a failure to visualise the problem of internal transport as a whole may lay unnecessary burdens upon the community. In the opening out of new country that may be the problem in South Africa. I venture to suggest that a courageous but, so far as is humanly possible, a 'scientific' policy of development by road and rail should be followed.

Science in Engineering.

The argument of this address can be summarised into a few sentences. New epoch-making developments in engineering depend upon the discovery of new facts of science and upon materials and technical processes. The only hope of solving many of the problems which face the engineer to-day is by carefully organised experiment. Engineering is of such vital importance to modern life that not only manufacturers but also large users, public authorities, and governments must be interested and provide funds for research.

In Great Britain a good deal of engineering research is being done by large firms, by research associations connected with certain industries, by the universities and by the technical colleges, the National Physical and the Building Research Laboratories, which are under the direction of the Department of Scientific and Industrial Research. This Department also assists research associations by grants, and the universities by the provision of research scholarships and research assistants, but at present it seems that sufficient research is not being done, and that not nearly enough research workers are being trained to meet the needs. How can the demands of the case be met?

It would appear that we must look largely to the universities to train research workers. Training in strict habits of observation and in the investigation of problems theoretically and by experiment should form part of the work of all engineering students. Much of the theoretical knowledge that a young engineer requires to learn is now to be found in excellent text-books and in current periodicals, and these he should be taught to read critically and with understanding, but he should also be taught to face all his problems in the spirit of an investigator. Certain selected students should be encouraged to remain at the universities after graduation or to return after some experience of actual works to engage specifically in research.

Engineering needs such men, some to give their whole time to research while others carry the spirit of research into the ordinary problems of industry and engineering. Employers, public authorities, and governments must utilise this research ability, and more men should find their way into industry from the research institutions. The universities, however, cannot do this most important work of training research workers unless they are adequately equipped and staffed to give members of the staff the necessary time for research and to devote themselves to the training of students in research. To this end sufficient funds must be provided from private and public sources.

The engineer is faced with many unsolved problems. Nevertheless, he must find immediate, if only approximate and tentative, solutions to many of them, and in the solution he often has to deal with many types of men. If experimental science and mathematics cannot give him an exact solution he must still carry on, and in this way much has been achieved. It is for this reason that the engineer has to learn much by actual experience in the workshop, in the field, and frequently he becomes impatient of science and lays too great emphasis upon experience. Manufacturers wish to see returns upon their capital and remuneration for their energy, but as an effective guarantee of future progress and in the solution of many problems in design, in processes, in materials, as well as in the discovery of new methods, it is necessary, as Francis Bacon would to-day remind us, "to apply natural philosophy to particular problems, and particular problems must be carried back to natural philosophy".

News and Views.

On Sept. 14 most hearty congratulations will be extended by a large circle of men of science in Great Britain and elsewhere to Prof. Ivan Petrovitch Pavlov, the distinguished Russian physiologist, on the occasion of his eightieth birthday. He was born—son of the village priest—in the district of Rjäsan, Russia, on Sept. 14, 1849. Pavlov, after graduating at the University of St. Petersburg, engaged in medical studies, showing, very early, marked aptitude for experimental research, combined with adaptability in matters requiring manipulative skill. This natural bent was encouraged by two years' guidance in Germany in the laboratories of Ludwig and Heidenhain. Returning to the Russian capital, Pavlov filled various important academical posts where his scientific activities and his acumen had ample play. Thus began that broad scheme of work, foreknowledge, and intensive application to novel modes of procedure which led ultimately to the opening of new chapters in physiological history. Little effort was required to attract to his laboratories pupils and associates who shared his patient enthusiasm.

Pavlov's earliest researches (dating from 1878) related to the physiology of the circulation, and the dog formed a convenient subject for observation. In these experiments he trained a dog to allow the insertion of a cannula in a small superficial artery on the inner side of the knee-joint and to remain quiet while the blood pressure was noted. Prof. E. H. Starling has recorded the extreme care and solicitude evinced throughout by Pavlov for the animals which were essential for his varied purposes. He would take them home from the laboratory and "in his small flat they would be looked after by his wife, with the

children". Long-continued and masterly investigations of the physiology of digestion received recognition in 1904 by the allotment of the Nobel prize for medicine. By the method which he called that of 'conditioned reflexes', Prof. Pavlov studied from a physiological point of view the influence of the higher brain centres upon the secretion of saliva. He was accorded a special welcome in London on Oct. 1, 1906, where he delivered the Huxley Lecture on various aspects of his exacting researches. In the following year Prof. Pavlov was elected a foreign member of the Royal Society, and in 1915 he was awarded the Copley Medal for his investigations in the physiology of digestion and the higher centres of the nervous system. We are glad to be able to publish a review elsewhere in this issue (p. 400) directing attention to Prof. Pavlov's collected addresses, which are now available in English. Readers of NATURE will remember that Prof. Pavlov's portrait appeared in our series of Scientific Worthies on Jan. 3, 1925.

THE Schneider trophy contest has been won for the second time in succession by Great Britain with an advance of mean speed over the performance of two years ago from 450 km./hr. to 530 km./hr. The details of the winning seaplane are still 'secret', and indeed the actual performance of the engine cannot yet be known accurately to the makers. A rough estimate puts the total weight at about 1½ tons with one hour's fuel, surface about 10 m.², span 8 m., power—an estimate so high as 1200 kw. has been published for the normal 600 kw. Rolls-Royce engine with special supercharging device—power plant weight 750 kgm. It will be understood that the figures are only intended to give an idea of the proportions of these racing machines, based on probable developments. The speed expected on a straight course is in the neighbourhood of 570 km./hr. or 160 m./sec.—exceeding half the speed of sound, which may be taken with some confidence as an upper limit. Hitherto the advances in speed have been roughly in equal steps, but in future the rate must fall off as the limit is approached.

THE theory of similar structures has been adduced to prove that, other things being equal, the smaller an aeroplane the better it flies, and the proposal has been made that racing aeroplanes should be built down to the smallest pilots available. The Italians have put this proposal into practice, but the other things were apparently not equal, and the theoretical view still awaits decisive confirmation. An objection has been made that the designer who is willing to risk the highest landing speed gains a decisive advantage over the others. Already the seaworthiness test has become more or less farcical, and the trial is one of pure speed. These points might be met by suitable rules, specifying the size and weight of the pilot, the minimum landing speed, and any other desired figures. But however this may be, the contest is bound to become each year more fantastically difficult and expensive until the trophy is won outright or until it dies out for want of competitors. In the meantime, it undoubtedly adds to the prestige of the winners.

LETTERS from rainfall observers in various parts of England, which have appeared in the daily papers, show that up to the end of August there were still districts where the rainfall of the present year was below 50 per cent of the normal, and that for many places this year's drought is the most severe for such a long period since reliable records began. At the end of June, regions with less than 50 per cent of the normal occurred in Ross and Cromarty, in the English Midlands, and in south-east England. Information from Scotland is scanty, but suggests that the rainfall of July and August has gone some way towards bringing the amount to a more normal proportion in the dry area of the north. Over England it is probable that the driest region is now more in the southern Midlands and the south-east rather than in the northern parts of Nottinghamshire and Derbyshire and southern Yorkshire. At Margate the total for the eight months was only 6·37 inches (48 per cent of the normal), and an observer in Pershore gives reports 7·54 inches compared with a normal of 15·27 inches (49 per cent). At Worksop the percentage is 50, at Skegness 51, at Bedford and Belper 55, and at Bradford 56. Farther south the very small total of 7·45 inches for the first eight months of the year is reported from Basingstoke.

EXCEPT for a week or two in the middle of July, exceptional heat has seldom accompanied the drought, and this has had an important effect in checking excessive evaporation and so moderating the ill effects of the drought on vegetation. From Aug. 31 up to Sept. 9, this has been very far from the case, especially in the south-east of England and the southern Midlands. Examination of the Greenwich records back to 1841 reveals only four occasions when anything comparable with the heat of the early days of this month has occurred in September, and all of these have, curiously enough, been within the last 35 years. In 1895 the maximum temperature exceeded 80° on six successive days, from Sept. 23 to Sept. 28. In both 1898 and 1906, 90° was attained three times, and in 1911 twice. The mean maximum for the first nine days of the present month—81·5°—was very slightly exceeded in 1911, but the nights then were not nearly so warm. The absolute extreme for the 89 years was 94°, on Sept. 8, 1911. Taking into account night as well as day temperatures, and the duration of this abnormal warmth, there can be little doubt that it will constitute a 'record' for autumnal heat for a considerable part of England, and considered in conjunction with the drought and the intense cold of February, will make 1929 one of the most interesting years meteorologically of which we have any record.

THE U.S. Bureau of Mines has just issued among its annual reports that upon coal in 1927. In addition to the usual statistical tables and graphs, there is an interesting review of the coal industry in the United States. It is shown that the output of bituminous coal in 1927 was exceptionally low, showing a decline of nearly 10 per cent below that of 1926. A part of this decline appears to have been due to lower home consumption as well as to a large falling off in the export trade, the report stating

that "from 21,510,000 net tons in 1926, when the overseas trade was greatly stimulated by the world-wide demand for coal caused by the British strike, sea-borne exports of bituminous coal fell to 3,288,000 tons in 1927". It is interesting to note that the falling off in the demand for bituminous coal appears to be due to a number of causes, one of them being the rapid growth of alternative sources of power, namely, oil, natural gas, and water power; another reason is the decided advance in fuel efficiency which is well marked in the case of railroad fuel, which absorbs about 24 per cent of the supply of bituminous coal; in the iron and steel industry, which absorbs about 16 per cent, and even more markedly in the consumption of coal by the electric utilities; in 1922 the average consumption per kilowatt-hour was about 6·6 lb. of coal, whereas in 1927 the average fell to 1·84 lb. On the other hand, there appears to be a small increase in the consumption of bituminous coal for domestic purposes, that is, for the heating of houses and other buildings.

THE Support of Workings in Mines Committee of the Safety in Mines Research Board has recently issued its fifth report (Safety in Mines Research Board, *Paper* No. 55. London: H.M. Stationery Office, 1929. 2*d.* net), dealing with the coalfields of Lancashire, Cheshire, and North Wales upon exactly similar lines to those adopted in the previous reports upon other British areas. The general impression given by this report is that the districts under investigation are not so well advanced in mining matters as some of the others already investigated; we find, for example, in the report such statements as these: "The accident rates from falls of ground in Lancashire and Cheshire and in North Wales are above the average for the whole country." "Very little machine mining is carried on." "In Lancashire and Cheshire the number of longwall machines in use is comparatively small." The same reflection emerges from the somewhat numerous recommendations put forward in the summary of the report, some of these being of the type that should, one would have thought, have naturally suggested themselves to those in charge of the mining operations.

IT is interesting to note that this report lays considerable stress upon the advantage to be obtained by the use of steel props, steel bars, and steel arches, which apparently have replaced wood only to a very small extent in the coalfields of Lancashire, Cheshire, and North Wales in spite of the great measure of success that has attended their employment in other districts. It is interesting to note that a very large variety of methods of working is employed under even apparently somewhat similar conditions, but unfortunately the report does not indicate which method or methods should receive the preference. It must not be forgotten that these coalfields present a number of difficulties in working; they are very much cut up by faults, some of which have an exceptionally large throw, and, further, the fields contain a large number of seams, some of which are occasionally leased to different collieries even in the same area, thus producing difficulties in working, which a more systematic method of attack could undoubtedly have avoided. Like the previous reports, this one contains a large amount of valuable information and hints which cannot but be of considerable advantage to those engaged in operating the coalfields under investigation.

As president of the sixteenth Indian Science Congress, held at Madras in January last, Prof. J. N. Mukherjee, of the University of Calcutta, presented a very interesting address entitled "The Physical and Chemical Points of View in the Theoretical Treatment of Colloids". Prof. Mukherjee is well known as the chief exponent of colloid chemistry in India, and the work which he has carried out, either alone or with numerous collaborators, has established his reputation throughout the scientific world as an eminent worker in this field. His address to the Indian Science Congress deals with some very difficult questions. It may be divided into three parts. In the first part the author discusses the colloidal particle as a molecule in the physical and in the chemical sense; whilst in the second part he deals with the thermodynamic treatment of colloidal systems. These very interesting sections of his address treat the much-debated question as to how far a colloid particle may be regarded as a thermodynamic component of a one-phase system, and as to how far this concept breaks down in many cases. The considerations which he advances will do much to remove misunderstanding in this part of the subject.

IN the latter part of his address, Prof. Mukherjee contrasts the surface association theory and the theory of ion adsorption, and points out that the former theory, which is of a more chemical character, leads to many difficulties and must in general be replaced by the theory of ionic adsorption. A good deal of Prof. Mukherjee's own work has dealt with this subject, so that he is able to discuss it from intimate acquaintance. The whole address is an excellent example of the great progress which India has made in science during the last twenty years or so, and, in spite of the modesty of the author, would have been listened to with attention and interest in any body of scientific men throughout the world. Prof. Mukherjee has now established an active centre of colloid research in the University of Calcutta, as is evidenced by the numerous papers which he and his collaborators have published in recent years.

IN the account by Dr. Montandon of the new 'anthropoid' discovered by Dr. de Loys in South America which is to appear in the next issue of the *Journal de la Societe des Americanistes de Paris*, and of which advance copies are now available, attention is directed in a supplementary note to two pieces of documentary evidence which may have a bearing upon the question of the occurrence of apes or monkeys of unusual size in America. Of these, one is a reference to certain statues in Yucatan which are said to resemble the gorilla. They are exhibited in the Archæological and Historical Museum of Merida (Yucatan) and are said to have been discovered at Tekax. One of them appears to be bisexual, a feature which recalls the peculiarities of the sexual organs of

the female which was shot by Dr. de Loys. The general configuration of the statues is that of anthropoids of powerful physique. The second document is a reference in the "Cronica del Peru" of Pedro de Leon, dating from the middle of the sixteenth century, to certain very large apes of whom the Indians made sexual use, from which unions were said to have resulted monsters with the heads and sexual organs of men and the hands and feet of apes. They were of tall stature and hairy, and had no language, but gave voice to a plaintive cry. These references are of great interest in view of Dr. de Loys' discovery, though it is certainly remarkable that if monkeys or apes of this size and character were known to the Maya, they should have remained unrecorded by European observers until now.

THE editor of *Antiquity* has been a consistent advocate of the use of the aeroplane as an adjunct in archæological exploration. The numerous records of discovery which have appeared in the pages of that periodical more than justify his views. Perhaps the most important of these has been the detection of Woodhenge, the Wiltshire prehistoric monument in the form of a circle in which wooden posts were used instead of the, to us, more familiar stone. The editorial notes in the September issue of *Antiquity* record the discovery, again by aeroplane, of another Woodhenge, this time outside Norwich. It was detected by Wing-Commander Insall, on June 18 last. The site is in a grass field called Bridge Meadow, in the northern corner of the Parish of Arminghall, opposite Old Lakenham. It shows up well in the air photograph as two dark concentric rings with nine dark holes within the inner ring, representing without doubt the wooden post holes. The outer ring is 10 ft. wide, the inner 25 ft. wide with a gap or causeway 14 ft. wide. The editor, when flying over the site, made a further important discovery in the shape of two concentric rings half a mile to the south, which undoubtedly represent a disc barrow, the inner ring surrounding a small central burial ground. This, it is suggested, is probably contemporary with the Woodhenge circle, as a similar but even closer association occurs at Woodhenge in Wiltshire. In discussing the bearing of the discovery, the editor suggests that the evidence, pointing to the association of the Woodhenge type of monument with the Beaker Folk, would lead one to seek further traces of this people of Rhenish origin in East Anglia owing to its geographical position.

THE Indus and tributary streams from the Himalayas flood annually, but this year, as the result of abnormally heavy rains in the Punjab, Baluchistan, and Kashmir, the flooding is exceptionally heavy and is causing much devastation. The *Times* reports that near the end of August the waters of the Indus at Attock, with a height of above 66 feet, stood higher than at any period during the last half-century. This was a higher level than during the flood which recently resulted from the bursting of the Shyok glacier dam. The Jhelum and the Chenab are also in serious flood. Many towns are in peril and several railway lines are breached. Many villages have been overwhelmed. The peak of the flood was reported on Sept. 8 to have passed the Sukkur barrage, but the barrage structure is reported to be safe. Last week it was anticipated that a further rise of six inches in the level of the river would necessitate the evacuation of all the low-lying parts of the lower Indus valley. The one hope is that the river bed has been scoured deeper by the rush of the floods and so can carry more water than formerly. Strenuous efforts are being made to heighten and strengthen the bunds before the peak of the flood arrives.

THE opening of the great Alfred Beit bridge across the Limpopo River near Messina on Aug. 31 marked an important step in the development of communications in South Africa. The bridge, which is to take both rail and road traffic, is 1500 ft. in length and consists of fourteen spans. It will eventually allow the railway from Cape Town, Bloemfontein, and Pretoria to be continued to West Nicholson, and so connected with the railway to Bulawayo, Victoria Falls, and Katanga. This will provide an alternative route between Rhodesia and Cape Town and Durban, and will make Delagoa Bay a rival to Beira for Rhodesian sea-borne traffic. The line from the Limpopo bridge to Delagoa Bay is already in existence. The present railway routes to Rhodesia are either from Beira or from southern ports via Mafeking to the west of the Transvaal. The mileage between Durban and Bulawayo will be considerably shortened on the completion of the new line.

THE increasing need of reaching biological conclusions regarding the slaughter of whales is emphasised in the second Annual Report of the *Discovery* Investigations (London: H.M. Stationery Office, 1929. 1*s*. net) which covers a period of seventeen months. The Antarctic whaling season of 1927–28 broke all records. Off the South Shetlands, 5500 whales were taken and the yield of oil (47 per cent more than that of the previous season, which itself was all but a record) was more than 66,000 tons; while together the Falkland Island Dependencies exported 134,000 tons of oil, of a value of £28-£30 a ton. The question is whether this enormous slaughter can be sustained without undermining the stock. The *Discovery's* results sound a grave note of warning. A very large proportion of the whales examined from the general catch were immature—in 1925–26, 58 per cent of blue whales and 26 per cent of fin whales. Though these may not have been fair samples of the whole stock, it is clear the proportion suggests a wanton and wasteful slaying. This is the more to be deplored since the evidence collected by the investigators shows that the whale stock is slow-breeding and therefore slow in recuperation. The period of gestation appears to be about a year, and young to be born once in two years at most.

THE proceedings of the Third Pan-Pacific Science Congress, which was held at Tokyo in October and November 1926, have recently been published by the National Research Council of Japan. They occupy two volumes containing nearly 3000 pages, practically all in English, the exceptions being in French and

German. More than 2500 pages are devoted to technical communications on astronomy, meteorology, oceanography, seismology, terrestrial magnetism, geology, geography, botany, zoology, anthropology, architecture, agriculture, and medicine, with a direct bearing on the Pacific region, its neighbouring lands and their inhabitants. Many of these communications are of high scientific merit, and the *Proceedings* as a whole represent a contribution to knowledge of the greatest value. Apart from their use as an encyclopædia on the Pacific, showing the present state of knowledge on the subjects treated and also various large-scale plans for the increasing of such knowledge, these volumes are very well worthy of study as showing what is possible in a great international congress. Most of the communications were made before large and appreciative audiences, and provoked discussions of the best type. The National Research Council of Japan is to be congratulated both on the volumes themselves and on the organisation of the Congress which was the reason for their appearance.

THE Colombo Museum, foreshadowed in Sir William Gregory's speech to the Legislative Council of Ceylon in 1873, was opened to the public in 1877. Accordingly, Dr. J. Pearson's Administrative Report for 1927, which has recently been received, takes occasion of the fiftieth anniversary of the opening to review the development of the Museum and its collections. The Museum owes its origin to the efforts of the Ceylon branch of the Royal Asiatic Society, and from the beginning its purpose has been strictly limited and defined—the storing and exhibiting of the productions of Ceylon. Even this limited field has required more space than was originally contemplated, and the original building, erected at a cost of Rs.120,500, was extended in 1907 and is now in course of further extension. The Director's suggestion that stone monuments, which need protection from sun and rain only, might be housed in an open roofed gallery, seems an excellent one. It is clear, however, that this side of the Museum's activities merits more attention than has been paid to it, and that the Museum staff requires strengthening by the addition of professional and technical workers familiar with the art and archæology of Ceylon, and with the preservation and preparation of art objects for exhibition. The use made of the library shows a gratifying increase.

IN "Zoologische Stationen" and "Fischerei-biologische Stationen", which form Lieferung 13, Teil 1, f_1 and f_2 of "Die Tierwelt der Nord- und Ostsee" (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1928), Dr. H. C. Redeke describes the marine zoological stations and fisheries institutes situated on the coasts of the North Sea and Baltic. The oldest North Sea station is that of the Niederländische Tierkundliche Gesellschaft, founded in 1872, since 1889 the permanent station of Helder, Holland. The largest, the Biologische Anstalt in Heligoland, was founded in 1892. There are altogether a dozen zoological stations distributed throughout the area described, in England, Scotland, Holland, Germany, Norway, Denmark, Sweden, Latvia, and Finland, besides the government fisheries stations in Belgium, Denmark, Germany, England, Scotland, Finland, Holland, Norway, Sweden, Russia, and Poland. Notes are given on all these, with the names of directors and staffs, amount of accommodation for workers and available boats for research, together with the organ (if any) in which the work of each one is published. A list of papers giving descriptions of most of the laboratories is also included. The whole forms a most useful work of reference.

THE seventy-fourth Annual International Exhibition of the Royal Photographic Society will be held at the Society's house at 35 Russell Square, London, W.C.1, on Sept. 14–Oct. 12.

THE sixth annual conference of the Association of Special Libraries and Information Bureaux will be held at Trinity College, Cambridge, on Sept. 20–22. The president-elect, Sir J. J. Thomson, will deliver an address on the first evening of the meeting, and afterwards Brigadier-General Magnus Mowat will review the past year's work of the Association, and Mr. Laurie Magnus will deal with the approach of the producer to the consumer of information. At the sectional meetings, such subjects as technical English, books versus text-books in schools, training of special librarians, and the international organisation of information services, will be discussed.

UNDER the Order in Council dated Feb. 6, 1928, the Lord President of the Council has appointed the Right Hon. Lord Rayleigh, Sir Arthur Balfour, Sir William Bragg, and Sir James Walker to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. The following members of the Advisory Council have retired on completion of their terms of office:—Sir Harold Carpenter, Dr. G. C. Clayton, Sir Richard Glazebrook, and Sir James Jeans.

AN International Congress of Archæology will be held at Barcelona on Sept. 23–29. The date coincides with the International Exhibition, in which an important place is being given to Spanish art and archæology. Excursions will form part of the programme to enable visitors to view the principal centres of archæological interest in the neighbourhood. Particulars of the Congress may be obtained from the secretary, Prof. Bosch-Gimpera, University, Barcelona.

A COMMITTEE has been appointed, consisting of Lord Weir of Eastwood (chairman), Sir Ralph Wedgwood, and Sir William McLintock, with the following terms of reference: "In view of the progress which is being made towards widespread availability of high tension electrical energy, to examine into the economic and other aspects of the electrification of the railway systems in Great Britain with particular reference to main line working". The secretary to the committee will be Colonel A. H. C. Trench, Ministry of Transport, 6 Whitehall Gardens, S.W.1.

ANOTHER interesting catalogue of Messrs. F. Edwards, Ltd., 83 High Street, Marylebone, W.1, has just been issued, namely, No. 517, entitled "Man through the Ages: his Origin, Customs, and Beliefs", being a list of upwards of 1300 second-hand works relating to anthropology and allied subjects.

IN the new edition in preparation of "Clegg's International Directory of the Book Trade" the section devoted to book collectors is being developed and the collectors are being classified according to the subjects in which they are interested. Anyone wishing to have his name included should communicate with "Clegg's International Directory of the Book Trade", Lodgewood, Gravesend, Kent, giving name, address, and subject of interest.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer and demonstrator in the Department of Zoology of the East London College—The Registrar, East London College, Mile End Road, E.1 (Sept. 14). A visiting teacher of mathematics at the Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (Sept. 16). A master of architecture at the King Edward VII. School of Art, Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (Sept. 18). Teachers of practical decorative painting and leaded glass work, design and construction of scroll and beaten lead work, design and the manufacture of ceramics and pottery, at the School of Applied Art, Cairo—The Under-Secretary of State, Ministry of Education, Cairo, Egypt (Sept. 20). A vice-principal of the County Training College, Crewe—The Secretary, Education Office, Municipal Buildings, Crewe (Sept. 27). An engineering inspector under the Ministry of Health—The Director of Establishments, Ministry of Health, Whitehall, S.W.1 (Sept. 28). A lecturer in engineering at the Witwatersrand Technical Institute—Chalmers and Guthrie (Merchants), Ltd., 9 Idol Lane, E.C.3 (Sept. 30). A head of the Engineering Department of the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth (Sept. 30). A vice-principal of the Training Department of Goldsmiths' College—The Warden, Goldsmiths' College, New Cross, S.E.14 (Oct. 3). A librarian and guide-lecturer at the Horniman Museum, Forest Hill—The Clerk of the London County Council, County Hall (Room 202), Westminster Bridge, S.E.1 (Oct. 8). A Stokes studentship at Pembroke College, Cambridge—The Master of Pembroke College, Cambridge (Oct. 10). A Secretary of the Museums Association—D. W. Herdman, Art Gallery and Museum, Cheltenham (Oct. 21). A trained bacteriologist for research upon cholera problems in the laboratory and field under the Indian Research Fund Association, also a research worker for work on malaria in the field and in the laboratory under the Malaria Survey of India—The Secretary, Indian Research Fund Association, Simla, India. A part-time demonstrator in chemistry at the University College of the South-West of England, Exeter—The Registrar, University College of the South-West of England, Exeter. A technical assistant in the Radium Department of St. Bartholomew's Hospital—Prof. F. L. Hopwood, St. Bartholomew's Hospital, E.C.1.

Our Astronomical Column.

A Flashing Meteor.—Mr. W. F. Denning writes: "I observed a flashing meteor on Saturday, Aug. 31, at $9^h\ 7^m$ P.M. Its motion was very swift and it gave a very brilliant flash at its disappearance, where it left a short, nearly vertical streak, about 2° long. The flash lit up the sky and country, but was of very transient duration and resembled lightning more than a meteoric outburst. The streak remained in view for six or seven seconds, and its position was from about 227° + 8° to 226° + 6°. Duration of the flash must have been a small fraction of a second, but the time interval was so brief that I could not estimate it exactly.

"I observed a well-defined shower of 12 Draconids on the same, and following, night from 292° + 61°, and the fireball's flight was directed from about this point. I attribute the object to this centre, though its aspect was not conformable with that of a normal Draconid. Fortunately, several others witnessed the flight of the meteor and roughly noticed its position and direction. It was seen from Truro and Camelford, and a rough projection makes the height of the object from about 69 to 57 miles, above points in the sea between the west extremity of Cornwall and 30 miles west of Pembrokeshire. Its velocity was probably much more than 50 miles per second. Occasionally other well-observed velocities have shown considerable discordances with those computed on the basis of parabolic or elliptical speed."

Silvering the 100-inch Mirror at Mount Wilson.—An interesting article by Mr. Russell W. Porter in the *Scientific American* for September describes the process of resilvering the great mirror of the 100-inch telescope at Mount Wilson, which is carried out every six months. The telescope is anchored in a vertical position, and the mirror lowered on a lift through a manhole in the floor. The old film is removed by acid; water jets are then turned on, and the mirror cleaned with cotton swabs. The reducing solution is poured on, and the silver solution added in two stages. It is left on for half an hour, being stirred meanwhile; the spent solution is drained off; the surface is washed and dried, and then polished, first with a cotton pad, afterwards with chamois and rouge. About a dozen men are occupied in the task, of which a coloured illustration is given. The final film is 1/100,000 of an inch thick, and contains only one per cent of the silver of the three pounds of nitrate of silver in the solution.

The Cowell Method of Computing Perturbations.—The method of mechanical quadratures introduced by Dr. P. H. Cowell for studying the perturbations of the eighth satellite of Jupiter and Halley's comet has been found convenient by many other computers. Dr. Innes, N. Komendantow, and Numerow have used it largely, but the two latter apply it in a modified form. Dr. G. Stracke contributes a table of the function ω^2k^2/r^3 to *Astr. Nach.* No. 5647; ω is the interval in days, k the Gaussian constant, r the distance from the sun. The values of ω in the table are 2^d, 4^d, 8^d, and the intervals of r are 0·01 from 1·50 to 6·00, and 0·1 from 6·0 to 35·0. The table serves for nearly all the minor planets and for many of the periodic comets.

Research Items.

Cranial Capacity of Filipinos.—Dr. Juan C. Nañagas of the College of Medicine, University of the Philippines, Manila, has made a study of the cranial capacity of a collection of some six hundred crania in the Department of Anatomy in his University. Of these there are a fair number of known cases of Filipinos; upon these is based a report published in the *Philippine Journal of Science* for January last. Of the four hundred and fifty-eight skulls examined, four hundred and thirty-six are males. The maximum cranial capacity for the male group is 1655 c.c., and the minimum, 1083 c.c. For the female group, based it is to be noted on only twenty-two specimens, the maximum is 1480 c.c. and the minimum 987 c.c. The main cranial capacities are for the male group 1301 c.c., with a standard deviation of 10·858; for the female group 1192 c.c., with a standard deviation of 11·8. A comparison with other races, white, Ainu, and negroes, both African and American, shows that in the Filipino cranial capacity is relatively smaller, falling more or less in direct proportion to the difference in stature and general physique existing among the various races.

Archæology in the Taos Valley, New Mexico—In 1920 a survey of archæological sites in the Taos Valley, New Mexico, was made by Mr. J. A. Jeançon, of which the results have been published in the *Smithsonian Miscellaneous Collections*, vol. 81, No. 12. The existence of prehistoric ruins here had been known for some time, but they had not been considered sufficiently important for excavation. As it turned out, this view was erroneous. Two mounds were excavated at Elano and their ruins of adobe buildings uncovered. The smaller was a seven-roomed house which showed evidence of long occupation. The second mound showed two levels of occupation, and a building belonging to the second was excavated. It had been an eighteen-room dwelling-house with a kiva. It had been destroyed by fire. No evidence was obtainable as to the method of roof construction except that the secular rooms had a central ceiling support, and the kiva covering had rested on four upright posts. The kiva had been placed in the centre of a compact mass of rooms instead of on an open plaza detached from the main building. The pottery gave evidence of a relationship to that of the south-western Colorado and the Rio Grande wares of the late black on white period. No special features occurred in the stone or horn objects found, the chief points to be noticed being the absence of grooved axes and the use of large pieces of micaceous schist for cooking slabs. It would appear that the culture of the sites represents a late phase of the black on white period just preceding the beginning of the glazed wares in the Rio Grande.

Animal Habits and their Association with Disease.—Apart from their public interest, the larger zoological gardens provide an important source of scientific research, particularly as regards the incidence of disease in the lower animals. In this respect the London Zoo stands in the forefront in its publication of reliable data, but even here no summing up of results has been attempted such as Herbert Fox gives in an unusual study contributed to *Proc. American Phil. Soc.*, vol. 68, No. 1. He examined, with the view of discovering the particular organ the breakdown of which caused the death of the creature, 2571 representatives of 37 families belonging to 5 orders, and varying in number from 2 giraffes to 429 old world monkeys. We mention one result as a sample of the conclusions reached. In the contrast between the causes of mortality in carnivores and herbivores, it is found that amongst the former, with their strong jaws, rapid deglutition, strong muscular intestines, and short digestive tract, there is outstanding susceptibility of the intestinal tract. Curiously enough, the least carnivorous of the lot, the bears, had the highest incidence in this respect. Otherwise, the carnivores show a greater tendency to ductless gland disorders and tumours. The herbivores, on the other hand, lead in diseases of the skeleton and in tuberculosis. These results are derived from captive animals, confined as regards activity and subject to unnatural feeding, so that they may not reveal quite the state of affairs in wild Nature; but until the field naturalist collects more data, they are the best that can be obtained.

Indian Oligochæta.—K. S. P. Aiyer (*Records Indian Mus.*, **31**, part 1, 1929), in an account of the Oligochæta of Travancore, records the finding of specimens of *Aeolosoma travancorense* in which there was not a compact testis; spermatogonia were found on the wall of the dorsal blood-vessel especially in the intestinal region. An ovary was not noticed in any of the numerous specimens examined, but in fully mature individuals a single large ovum was present, attached to the anterior end of which was a cell smaller in size and free from yolk granules. The author suggests that two oocytes are produced, the hinder one developing into the ovum and the anterior one remaining as a nurse cell. There are no spermathecæ, sperm ducts, or oviducts. The other aquatic Oligochæta are Naididæ, represented by eight genera and eighteen species, Tubificidæ, one species, and Enchytræidæ, one species. There are forty-nine terrestrial species recorded, chiefly Megascolecidæ. The most striking structural peculiarity is the presence in a *Megascolex* of a retractile proboscis about 4 mm. in length which arises from an invagination in the dorsal wall of the buccal cavity. It is supplied with a nerve from the same trunk as the prostomium, and the author states that it functions as a feeler. The vas deferens of *Moniligaster deshayesi* is surrounded by numerous leaf-like bodies, each of which is a mass of tubules, and opens into the vas deferens by a short duct. This is unique in the Oligochæta.

Caterpillars and Ants.—The association of ants with the larvæ of 'blue' butterflies has long been recognised, but an addition to our knowledge of the relationship in England has been made by Prof. J. W. Heslop Harrison and William Carter (*Vasculum* for August). Having earlier observed that the larvæ of the Brown Argus attracted ants, and that the seventh and eighth abdominal segments of the larvæ bore elaborate structures, which are believed to emit something in the nature of a scent attractive to ants, they have now solved the question of the identity of the ants themselves. A few of the rare larvæ were found on the leaves of the rock rose; in each case ants were present, and two species were represented—*Lasius niger* and *L. flavus*. The discovery explains the restricted distribution of the butterfly, which appears to be confined to certain hollows carrying an abundance of the thyme-clad hillocks of *Lasius flavus*. The association recalls and foreshadows the more intimate symbiosis in the case of the large blue, *Lycæna arion*, where the larvæ in their last stages live in the nests of, and depend entirely upon the ant *Lasius flavus*.

Floridan Tree Snails.—Those handsome, gaily coloured tree snails belonging to the genus *Liguus* being threatened with extinction, owing to the destruction with the advance of civilisation of the forest

patches they frequent, Mr. C. T. Simpson has been happily inspired, after thirty years' study, to place on record his observations concerning them (*Proc. U.S. Nat. Mus.*, vol. 73, art. 20). The genus, which according to the author includes about a dozen species and a great number of varieties, is found in the northern parts of South America, Cuba, Haiti, Cozumel, and the more tropical part of Florida. The colonisation of Florida took place since early Pleistocene times and originated from Cuba, where the genus was early established, possibly in Miocene times. How this migration was brought about by flotation during gales and the physical changes that afterwards assisted in the spread of the colonists is explained at some length if not altogether convincingly, since no fossil or subfossil occurrences are recorded. Full systematic descriptions of the thirty-five species, subspecies, and colour varieties existing in Florida are given, founded solely on shell characters, and illustrated with forty-six figures on four beautifully executed coloured plates.

Reproduction and Sex in *Ectocarpus*.—A further valuable study of the alternation of generations and of sexuality in *Ectocarpus siliculosus* has come from Miss Margery Knight (*Trans. Roy. Soc. Edin.*, **56**, No. 15, pp. 307-322), who has discovered a striking difference in the life history of this species in British waters and at Naples. In Britain the plant is normally diploid, giving rise to diploid and asexual zoids from plurilocular sporangia. Alternatively, meiosis in the mother cell of the unilocular sporangia is followed by the production of zoids which behave as gametes and, on fusion, re-establish the diploid soma. In Neapolitan examples of the same species, the zoids from plurilocular sporangia are undoubtedly gametal in nature, and both the mature plant and the plurilocular sporangia have *haploid* cells. The absence of unilocular sporangia in the Neapolitan material is interpreted as an indication of the haploid nature of the normal soma. The author's work on the sexuality of the zoids in general confirms that of Hartmann, who found that fusions only took place when the gametes (from different plants) were of sufficiently high and opposite sexual potential. There is also evidence, however, that the numbers of zoid fusions decreased very rapidly after the plants were exposed to light, owing to some effect of the changing environment upon the zoids. Sexual potential might thus be regarded as a function of the previous experience and immediate environment of the individual gamete rather than as a fundamental and constant quality of the parent plant. Further, in some cases, male and female zoids appeared to be produced from a single plant simultaneously. The male zoids could be distinguished from the female by their higher fucosan content, and it appears that the proportion of male to female zoids from a single plant may decrease rapidly during the course of an hour or two. The sex difference is thus associated with metabolic activities and it is, accordingly, not impossible that the previous physiological history of the parent plant might determine whether the plant produced wholly male or wholly female zoids.

Population Studies.—At the July meeting of the Royal Society of South Australia, Dr. Charles Fenner, the acting president, read a paper entitled "A Geographical Enquiry into the Growth, Distribution, and Movement of Population in South Australia, 1836–1927". Though much valuable work along those lines has been done elsewhere, this is the first exhaustive inquiry of its type that has been conducted in Australia. The paper dealt with the whole period of South Australia from its foundation; the initiation and development of the chief influencing factors, such as topography, soil, climate, water supply, railways, harbours, roads, education, research, and invention, were shown in a series of ingenious maps and graphs, and were duly correlated. The population growth and movement were set out graphically on a series of 'spot-maps' (one dot per hundred persons),—one map for each decennial period. The closing portion dealt with what Dr. Fenner calls the 'prosperity graph' of South Australia, which shows in one curve the whole history of the State, with annotations indicating the chief factors and incidents in its development, from the geographical point of view. This graph, which is based on the power of the State to absorb or to repel population from outside, shows a high degree of correlation with other factors that might be regarded as measures of State prosperity or adversity.

Manganese in South Africa.—The recent discovery of important manganese deposits along some thirty-eight miles of the Gamagara ridge near Postmasburg, in the Cape Province, has led to a detailed survey of the ore bodies and the surrounding geological formations ("The Geology of the Postmasburg Manganese Deposits", by L. T. Nel, Geological Survey of South Africa). The deposits occur in two belts running north and south, the western belt being associated with the basal members of the Gamagara Series, whereas the eastern belt is in the Blinkklip breccia or underlying chert breccia. In each the Campbell Rand Series of limestones, dolomites, and cherts is found underlying the ore belt, and while it is not yet clear where the manganese came from, the evidence is strongly in favour of its having been leached from these limestones and reprecipitated as oxide by metasomatic replacement in the situations where it now occurs. There are two principal varieties of ore: one massive and agreeing in composition and properties with *psilomelane*, the other crystalline and corresponding most nearly to *braunite*. The two varieties are intimately associated and they occur in conjunction with manganiferous iron ores. The available tonnage of ore with 40-50 per cent of manganese is enormous, and there are large reserves of higher-grade ore carrying more than 50 per cent manganese. Among the other minerals found in the ore bodies are claret or rose-coloured *manganese-diaspore* and a delicate rose-coloured *soda-rich mica*, representing probably a new species of the mica group.

Simple Soil-Testing Outfit.—The chief aim of the golf greenkeeper is to maintain soil conditions which will encourage fine grasses and at the same time prevent or appreciably reduce the occurrence of clovers, weeds, coarse grass, and earth-worms. It is now well known that this type of herbage is obtained if the soil is acid in reaction, a condition which can be brought about by repeated light dressings of sulphate of ammonia. It is therefore important that greenkeepers should be able to test their soil from time to time by some simple method, so that they may be guided in their treatment. To meet this need the British Drug Houses, Ltd., London, N.1, have produced a 'Golf Links Outfit', in which all accessories for the determination of soil reaction (with the exception of distilled water), are included in a compact leather-board pocket case, price £2 5*s*. A preliminary test is made with B. D. H. Soil Indicator, and the exact *p*H value is then determined by means of the B. D. H. Capillator. Full instructions for the use of the outfit are supplied and a price list of spare items is appended.

Radium *D*.—The issue of the *Zeitschrift für Physik* for June 27 contains two papers from Prof. Meitner's

laboratory, by J. Petrová, in which he describes a modified form of the Wilson cloud apparatus and its application to the study of the β-rays from radium D. The apparatus has been designed so that it can be used with the expansion chamber containing gas at a pressure only slightly in excess of that of the water vapour, and is thus specially well suited for the investigation of particles of short range. The two groups of β-particles which correspond to the two strong lines in the magnetic spectrum of radium D at 30 kilovolts and 43 kilovolts have been resolved in a statistical analysis of the lengths of the trails, and there are also present a number of faster particles, as well as some slow β-particles which are probably the nuclear rays from this element. The papers are illustrated by some good stereoscopic photographs of β-trails, and one of some α-trails in air at low pressure from which numerous long δ-rays are projecting.

Origin of Magnetism of Sun and Earth.—The issue of the *Physical Review* for July 15 is the second for the month, and henceforth it will appear twice a month. The two issues cover the first 386 pages of Volume 34. The later one contains a new theory to account for the magnetic fields of the sun and of the earth by Mr. R. Gunn, of the Naval Research Laboratory, Washington. According to this theory, an electron in motion in the $X\,Y$ plane in a non-homogeneous magnetic field in the Z direction drifts in the X direction by an amount which depends on the rate of change of the magnetic field in the Y direction, which is taken along the gravitational field. This field produces a drift in the $-X$ direction, and if there is an electrostatic field it may produce a drift in either direction along the X-axis. It is shown that the first of these drifts is the greatest and that the electric current due to it is of the right order for both sun and earth. This current is in the direction to increase the magnetic field, but this increase is kept in check by radial electric fields due to temperature gradients and differences of ionic concentration.

Chemical Biogenesis.—Prof. John Read (*Chemistry and Industry*, vol. 48, No. 32, p. 786, Aug. 9, 1929) points out that close structural relationships are often observed to exist between the individual components of a particular essential oil, and that striking parallels may be discerned in many instances between groups of substances occurring in two or more oils from related species. These facts lead to the idea of the derivation in the plant of related substances from common chemical ancestors, as was remarked by Kremers in 1922. Prof. Read suggests that geraniol (or, possibly, its geometrical isomer, nerol) possesses strong claims to be regarded as the immediate precursor of piperitol, piperitone, Δ^4-carene, and other substances which occur in this association in essential oils. All these substances may be depicted as obtained from the parent compound by simple processes of isomerisation, hydration, dehydration, oxidation, and reduction, while geraniol itself may originate from such simple units as *iso*-valeraldehyde. The implied aptitude of geraniol to act in Nature as a precursor of so many other substances may be attributed to the unusual conformation of its molecule, which possesses a structure $-CMe:CH\,.\,CH_2OH$ (consisting of a primary alcohol group activated by an $\alpha\beta$-ethylenic linkage) situated in spatial proximity to a second active grouping $-CH:CMe_2$. Migration of a hydrogen atom, in the 'nascent' molecule of geraniol, from the primary alcohol group to one side of the double bond of the second grouping leads to piperitol, piperitone, and α-phellandrene; migration of the same hydrogen atom to the other side of the double bond leads to Δ^4-carene. Prof. Read hopes to submit his interesting ideas to experimental investigation; the problem is certainly an important one, and its solution would throw welcome light upon biogenetical relationships.

Flame Speeds.—Messrs. W. Payman and R. V. Wheeler have had reprinted as a memoir the articles by them on "Flame Speeds and their Calculation" published this year in *Fuel in Science and Practice*. In this they summarise the results of many previous papers, and answer some of the criticisms advanced against the general applicability of the 'law of flame-speeds'. Assuming Le Chatelier's initial phase of slow uniform movement, which we think the authors have established, we may note the curious and significant result—that, when oxygen is diluted with nitrogen to different strengths, the *limit* mixtures of all such atmospheres with a combustible gas, such as methane, propagate this slow flame at a nearly constant velocity—about 20 cm. per sec. The authors find experimentally that all such limit mixtures (of the same kind), made by paraffin-gases with air or oxygen, when mixed together, also form a limit mixture in which flame travels with the same velocity. Again, the authors find that, as a general rule, mixtures of different gases in air or oxygen which have the same flame-speed may be mixed together to give a mixture having the same flame-speed; from this they argue that the two reactions take place independently of one another. It is pointed out that this conclusion is only valid when the combustible gases do not interact in the flame, and where none of the combustible gases decomposes with evolution of heat. Hydrogen mixtures, towards either limit, show variations from the normal owing to the mobility of the H_2 molecule, and carbon monoxide requires the presence of hydrogen or steam to exhibit its due effect. Nevertheless, the authors show that the generalisation is applicable in the case of most industrial gases, and can be usefully employed, for example, in the regulation of gas-fired retorts.

Testing Wire Ropes.—A method of testing for mechanical flaws in wire ropes without subjecting them to actual mechanical tension is a problem which has been studied for many years, especially by colliery engineers. There is an urgent need of some simple method of testing wire ropes so that incipient flaws due to cracked or broken wires may be detected as soon as possible. An ideal method for making such a test seems to be a magnetic method. Such a method of testing wire ropes is described by Dr. Wall in the *Journal* of the Institution of Electrical Engineers for July. The principle used is to employ a 'search band of magnetic flux' which is linked with a search coil system. Any flaw in the rope alters the reluctance of the circuit of the flux, and this produces a variation in the electromotive force in the search coil system which can be detected at once by a suitable recording instrument. It is therefore possible to pass the wire rope at a slow speed through the magnetic instrument, any flaws being at once shown by a change in the position of the pen of the recorder. Experimental details are given of the depth of the penetration of the alternating magnetic flux into the wire rope at different frequencies and on the effect of mechanical strain on the permeability. Experience has shown that mechanical flaws not weakening the average mechanical strength of the rope by more than about 10 per cent need not be considered, as this does not appreciably endanger its safety. It is only when more than 10 per cent of the section fails that a watch needs to be kept on the faulty section to see whether its develops further. A complete wire rope testing equipment of this type has been installed in the Hatfield Main Colliery near Doncaster. The diameter of the winding rope is $2\frac{1}{8}$ inches and the pit shaft is 860 yards deep.

Conference of Empire Meteorologists.

THE last ten days in August witnessed a meeting in London of official meteorologists from all parts of the British Empire. Ten years ago advantage was taken of the presence in London of the directors of many of the overseas observatories and services to hold a meeting for the discussion of matters of common interest, but the present is the first occasion on which invitations to send delegates to a formal conference were issued through official channels to all Dominions, Crown Colonies, and Protectorates.

The need for such a gathering has arisen from two main causes, the development of aviation and the extension of wireless as a means of communication. Long distance flying is now an accomplished fact, and the establishment of regular services between different parts of the Empire can only be a matter of time, but if they are to function with the maximum of safety and regularity, adequate meteorological services, implying close co-operation between the different meteorological authorities, are essential.

Again, the development of wireless as a means of communication has revolutionised the technique of synoptic meteorology. Ten years ago the European countries, North America, India, and Australia formed self-contained units from the forecasting point of view, and it mattered little whether there was uniformity of codes and methods. To-day all that is fast changing. The weather chart drawn each morning in the Meteorological Office now covers almost the whole of the northern hemisphere, and the maps of other services have undergone a similar enlargement of area. The consequence is considerable overlapping, which has made itself felt as a distinct inconvenience and waste of effort, more particularly in the demands made upon ships at sea. All meteorological services want reports from the oceans near their coasts, and each not unnaturally tends to impose its own hours of observation, codes, and other conventions on the ships that report to it, and it is easy to see that in such circumstances shipmasters may be embarrassed by conflicting demands. The matter is one that can be adjusted satisfactorily only by international agreement, but a survey of the position from the point of view of the British Empire will be helpful to that end.

Such were in brief the considerations which led to the calling of the Conference. It is gratifying to record that the response to the invitations was cordial. Canada (with Newfoundland) was represented by the newly appointed Director of its Meteorological Office, Mr. G. M. Patterson; India by the Director-General of Observatories, Dr. C. W. B. Normand; South Africa by Mr. C. Stewart, Chief Meteorologist; New Zealand, by Colonel D. C. Bates. Mr. A. Walter, the Director of the newly created meteorological service of the East African Group (Kenya, Uganda, Tanganyika, Rhodesia); Mr. A. J. Bamford, Superintendent of the Colombo Observatory, and Mr. T. F. Claxton, Director of the Royal Observatory of Hong-Kong, represented their respective services; and Mr. L. G. Sutton, Director of the Meteorological Service of Egypt, acted as unofficial observer for the Egyptian Government. Delegates were also sent by the following Governments, which do not, as yet, maintain meteorological services employing full-time meteorologists: Irish Free State, Somaliland, Nyasaland, Nigeria, Gold Coast, Sierra Leone, Gambia, Barbados, Windward Islands, Trinidad, Leeward Islands. Malaya, which has just started a service, was represented by Mr. J. Dewar, Assistant Surveyor-General. It is much to be regretted that Mr. H. A. Hunt, Director of the Commonwealth Weather Bureau, was not present; Captain H. J. Feakes attended on behalf of the High Commissioner to represent the Australian Service.

The proceedings opened on Tuesday, Aug. 20, at the Air Ministry, when Lord Thomson, Secretary of State for Air, welcomed the delegates on behalf of the Government. In his address he reviewed briefly the circumstances that had led up to the Conference and assured the delegates of the great importance which the Government, and more particularly the Air Ministry, attached to their work. Dr. G. C. Simpson was elected president of the Conference. The first subject to receive detailed consideration was the application of meteorology to aviation. Official visits were paid to the terminal aerodrome at Croydon and the Royal Airship Works at Cardington. At the former the delegates had an opportunity of seeing for themselves the elaborate meteorological organisation that caters for the requirements of civil flying between England and the Continent. By the courtesy of Imperial Airways, Ltd., a short flight in an air liner that afterwards left for Paris was arranged for those who wished to take part in it. At Cardington the morning was devoted to an inspection of the airship now rapidly approaching completion, and of the arrangement for mooring at the mast. During the afternoon the staff of the Meteorological Office demonstrated the special work that has been undertaken as a preliminary survey of the meteorological conditions on the England-India air route, and the researches into wind structure that have been carried out.

The discussion which occupied the two meetings held on the following day consisted in large measure of an exchange of information as to how far each Dominion or Colony could supply information of the kind shown to be necessary. The purely climatological observations to which routine work has hitherto been restricted in most Colonies require to be supplemented by observations of visibility, height and amount of low cloud, direction and velocity of upper winds obtained with pilot balloons, and if possible also of temperature in the free air as recorded by aeroplanes or by registering balloons. The exchange of ideas on methods of observation and their feasibility for use by observers in tropical countries promises to give valuable results. The suitability of the international forms for statistical summaries of these new observations for use in the special circumstances of each Colony also came up for discussion. Sub-committees were then formed to consider in detail the arrangements along various projected routes for long-distance flights.

The discussions on marine meteorology occupied three whole mornings. Technical questions of codes for wireless transmissions occupied a good deal of time, but the main questions of general interest were the use of the Hollerith machine for the statistical treatment of data from the sea and the organisation of the collection of data from ships flying the British flag. The labour of combining observations from moving observatories such as ships in statistical summaries is very great and the Hollerith system, which has been adopted by the British Meteorological Office and also by some services on the Continent, greatly reduces that labour and facilitates the exchange of observations. A visit was paid to the offices of the British Tabulating Company, where the work was demonstrated in detail. On the question of organisation, the goal to be aimed at is that each Dominion that has an office for marine meteorology should superintend the ships registered in its own ports, and that

adequate arrangements should be made for the exchange of the data between the central offices.

At other meetings the special requirements of the Army and Navy were discussed, and the arrangements that have been worked out for meeting them in Great Britain were laid before the delegates. Another important discussion centred around the arrangement under which reprints of the meteorological summaries appearing in Colonial Blue Books are supplied to the London Meteorological Office for distribution to meteorological libraries in all parts of the world. That system for rendering accessible the meteorological records of our colonies was introduced early in the century, but the present occasion has been the first opportunity for discussing it by those primarily concerned in making it a success. There was also a discussion on seasonal forecasting.

It will be observed that the subjects so far enumerated, with the exception of seasonal forecasting, concerned themselves with questions of organisation. On the last two days the meetings were of a different character. The subjects were grouped under the general heading agricultural meteorology, and the discussion was thrown open to all workers in Great Britain who co-operate in the crop-weather scheme, carried out jointly by the Ministry of Agriculture and Fisheries and the Meteorological Office, and agricultural delegates from many Colonies and Protectorates also attended. The large hall of the Civil Service Commission in Burlington Gardens was secured to accommodate the larger audience, and the details of the arrangements were made by Mr. W. R. Black of the Ministry of Agriculture. Sir Napier Shaw acted as president. The discussion covered a wide range of subjects connected with the response of crops to weather influences and a valuable exchange of views and experiences resulted. Visits to the Lord Wandsworth Agricultural College at Long Sutton, to the Royal Horticultural Society's Gardens at Wisley and to the Rothamsted Experimental Station were arranged in connexion with the Agricultural Section of the Conference.

On Friday, Aug. 24, Government hospitality was extended to the delegates at a dinner at which Mr. F. Montague, Under-Secretary of State for Air, took the chair.

Pollution and Bottom Fauna.

MR. R. E. RICHARDSON, in his paper "The Bottom Fauna of the Middle Illinois River, 1913–1925; its Distribution, Abundance, Valuation, and Index Value in the Study of Stream Pollution" (State of Illinois Department of Registration and Education, Division of Natural History Survey, Bulletin, Vol. 17, Article 12; 1928), discusses the bottom fauna of the Illinois River and its relation to pollution. These studies have been going on from 1874 until 1927 and many changes in conditions have been experienced during that time, affecting profoundly the biology of the river. The most important changes are first, the introduction in 1885 of the European carp with its rapid multiplication, its yield by 1908 to the commercial fishermen being greater than all the other fishes taken together; secondly, the completion and opening in January 1900 of the drainage canal of the Sanitary District of Chicago; and thirdly, a general movement for the reclamation of land.

The present bulletin deals with the researches of the last twelve years, based on the study of 1308 biological collections made over a stretch of 225 miles of the Illinois River and its connected bottomland lakes. The upper part is powerfully affected by pollution which diminishes slowly downstream and varies considerably during the year, and by studying the plants and animals characteristic of septic, pollutional, sub-pollutional, and clean water an effort has been made to select an index series of species the abundance of which marks the grade of pollution in which each species predominates, the conclusion being, however, that as each series grades almost imperceptibly into another a dependable classification can only be successful by the supplementing of chemical data and a study of the dominant flora and fauna in each situation. Increase of pollution is shown by the decrease in the number of species in the bottom fauna and in the disappearance of characteristically clean-water species, also in the dissolved oxygen data which show a rapid decline from 1912 to 1920, a partial recovery occurring after the War. Together with the decrease in bottom species is a rapid increase of the sludge-worms (Tubificidæ) and midge larvæ (*Chironomus*), which multiplied enormously. A recovery in the number of the clean-water Sphæriidæ was checked and reversed by an outbreak of leeches preying on them. After prolonged floods in the summer of 1924, which probably carried down much sludge, there was a huge increase of sludge-worms, midge larvæ, and the small bivalve *Musculium transversum*, which is tolerant of pollutional conditions.

A study of competition and depredation in the more important groups shows that under clean-water conditions snails tend to dominate and to suppress midges, sludge-worms and the smaller Sphæriidæ, and sucker-mouthed fishes eat largely the smaller mollusks, midge larvæ, may-flies, and caddis flies. Only catfishes and 'sheepsheads' live on the larger snails. Thus the destruction of the snails by pollution and the consequent sparing of the small Sphæriidæ affords increased food to the coarse fish and may be of benefit to the commercial fisheries, but on the other hand the gassy taste of some of the fish and the frequently diseased condition, as in the carp, due to pollution, diminishes their market value.

The small bottom fauna recovers more slowly from pollution than the plankton of the surface layers, lagging behind the dissolved oxygen, probably because of the naturally slow rate of respread upstream of cleaner water forms, and also because of the fresh loads of incompletely oxidised organic sediment which come down with every flood. The small bottom animals, except where pollution is very heavy, thus furnish a better index of ordinary sanitary conditions than do the plankton or dissolved oxygen.

Economic Status of University Staffs in the United States.

THE learned world's earnings and spendings was the subject of a symposium, published in *Science* July 12 and 19, of papers read at meetings of the American Association for the Advancement of Science in New York last December. The budgets of university teachers are discussed under: (1) professional needs, (2) requirements of daily living, (3) necessary provision for financial security of self and family; and the conclusions reached, after a survey of statistics too meagre as a basis of generalisation but useful for clarifying the discussions, are given in the form of a tentative budget. This suggests a minimum of

10 per cent of income for (1), 15 or more per cent for (3), and about 75 per cent for (2). Professional needs (envisaged as the reinvestment in his work by a productive worker of part of his annual income to increase his productivity) are assumed to include membership in four or more professional organisations, attendance at one or two professional meetings, professional books (fifteen or more) and journals (four or more), clerical assistance, research, equipment, committees, etc., and travel for cultural purposes. Life insurance seems to be universal, but only about half of the teachers included in the statistical survey use the retirement annuity plan (5 per cent contribution from salary matched by 5 per cent from the institution), and the suggested budget allotment under head (3) is admittedly in excess of what is usual or possible among lower-grade teachers.

The course of teachers' salaries from 1914 to 1927 has been exhaustively studied, the data including reports from 302 universities and colleges concerning 15,361 teachers. The real increase since 1914, allowing for the rise in the cost of living, has been very slight, and almost two-thirds of the teachers are compelled to take on additional work to meet their economic needs, earning thus on an average 24 per cent of their regular salaries, and the higher the professional rank the greater is the economic pressure. Seventy per cent of those who do extra work do extra teaching, 25 per cent earn money by writing, 20 per cent lecture, 10 per cent do consulting work, and 25 per cent sell other services, the range of earning being from less than 100 dollars to more than 10,000 dollars, and the median 522 dollars.

A comparison has been carefully worked out of salaries in (*a*) manufacturing enterprises, (*b*) universities, (*c*) army, (*d*) navy, and (*e*) the professional and scientific grades of the U.S. Civil Service. From this we learn, for example, that 3000 dollars will buy (*a*) a young or unsuccessful salesman, (*b*) a high average assistant professor, (*c*) a young first-lieutenant, (*d*) a medium-rate ensign, or (*e*) a high assistant in professional *or* sub-professional grade.

Reviewing the facts brought out in these papers the writer of the last of the series observes: "For the future of science it is much more important that the supply of scientific workers be limited to those who can be placed at adequate salaries than it is to train or partially train large numbers and have many working for unsatisfactory salaries".

University and Educational Intelligence.

CAMBRIDGE.—The John Winbolt Prize (value about £15) for the best exercise on some subject related to the profession of a civil engineer, has been awarded to J. N. Goodier, of Downing College, and H. S. Sayles, of St. John's College, for their joint dissertation on "Some Problems of Plane Stress".

THE London County Council is this winter again making provision for the continued efficiency of its teachers by arranging a comprehensive series of lectures covering all aspects of school work. A Handbook giving the titles and synopses of lectures and courses has been issued recently from the County Hall, Westminster Bridge, London, S.E.1. It is difficult to single out items for mention, but readers of NATURE will be interested in the special single lectures under the heading of geography by Mr. F. J. R. Rodd on the Sahara, by Mr. J. M. Wordie on Greenland, and by Mr. A. Hamilton Rice on the Amazon. Mr. R. Phillips is giving a course on weather study in schools. The mathematical section includes a course on school geometry by Prof. T. P. Nunn and another by Mr. W. C. Fletcher on the teaching of mathematics; there are also courses on psychology in relation to school work. Science in boys' and in girls' schools is dealt with in other courses, Dr. R. S. Clay is giving a course on recent developments in physics, and Prof. C. R. Darling another on electricity in the home. Science teachers are also offered tickets of admission to the meetings of several scientific societies. The fees for teachers working in London, Croydon, Kent, or Middlesex average less than 1*s.* a lecture.

THE Loughborough College Calendar for 1929–30 gives particulars of courses in its two faculties, engineering and pure and applied science (including chemical technology), in its junior department (a public secondary school designed to meet the requirements of boys wishing to enter engineering professions), and in its school of industrial and fine art. A distinctive feature of its engineering courses is that theoretical and practical training is given concurrently. Its workshops being equipped for producing all types of engineering components upon a productive basis, the student is able to complete his training without seeking practical experience in outside engineering works. The College diploma in mechanical, electrical, or automobile engineering involves five years of residence, in civil engineering four years, and in commercial or chemical engineering or chemical technology three years. Five open British Empire scholarships in the faculty of engineering, worth £75 per annum, for the period of the full diploma course, are awarded annually. These have drawn students from many parts of England and three from overseas. The College has a department of extramural adult education with staff tutors in economics, literature, political science, and psychology, controlled by a sub-committee of the Nottingham University College Joint Committee for Tutorial Classes.

FROM the Carnegie Endowment for International Peace we have received a copy of the annual report on its Division of Intercourse and Education. The divisional director, Dr. Nicholas Murray Butler (who is also president of the Endowment) summarises in 92 pages the many-sided activities whereby, at a cost during 1927–28 of 378,869 dollars, it has been making its influence increasingly felt in almost every country in the world. Its largest single undertaking was a two-months visit by fourteen British journalists to the United States as its guests. This cost 60,000 dollars. An equal amount was devoted to the maintenance of and work through its "Centre Européen" at Paris, including its official organ, the quarterly review, *L'Esprit International*. Large sums were also devoted to reorganising, with the aid of a group of American librarians, the colossal Vatican library, and to the expenses of a scheme for the appointment of visiting professors of international relations. Some fourteen professors of various subjects in American universities who happened to be visiting foreign countries for their own purposes accepted appointment as Carnegie professors for the delivery of a few public or academic lectures and for series of intimate conferences and discussions with professors and advanced students. Two others, Dr. David P. Barrows of California and Dr. Henry Suzzallo of Seattle, visited respectively the Latin-American States and central Europe entirely under the auspices of the Endowment. Among numerous subventions of enterprises deemed valuable as agencies for fostering international goodwill and understanding was a grant of 5000 dollars towards the expenses of delegates of the principal entomological societies of Europe attending the fourth International Congress on Entomology at Cornell University.

Calendar of Patent Records.

September 14, 1815.—The metronome, as it is known to-day, was patented in France on Sept. 14, 1815, by J. N. Mälzel of Ratisbon, who was a friend of Beethoven and a well-known mechanician who toured through Europe with various automata and a mechanical orchestra of his own devising. His right to be called the inventor of the metronome was denied by the Dutch Academy in favour of the Dutchman Winkel, but it was Mälzel who set up the first factory for its manufacture in Paris in 1816.

September 15, 1594. — On Sept. 15, 1594, a Venetian patent for twenty years was granted to Galileo for a machine for raising water and irrigating land which, with the motive power of a single horse, would continuously discharge water through twenty spouts. Nothing is known of the machine, but the patent is interesting as showing the similarity of the early Venetian and English patent practice. The extant documents include (1) a petition from Galileo to the Doge for the grant of a privilege for forty years for his invention "found by me at great trouble and expense", (2) a request from the Council for a report on the petition from the "Provveditori di Commun", (3) the report recommending a grant for twenty years, (4) the Council's approval of the report and (5) the grant of the Doge, with a stipulation that Galileo was to construct a machine within one year.

September 15, 1806.—Joseph Manton's double-barrel shot-gun with elevation top-rib was patented on Sept. 15, 1806. Manton was the most celebrated British gunsmith of the first half of the nineteenth century. He took out several patents, but his deservedly high reputation was due more to his excellent workmanship than to his inventions, which, with the litigation to which they led him, absorbed all his profits and left him bankrupt at the end.

September 15, 1902.—The Owens' bottle-making machine, in which the manufacture is entirely automatic from the raw material to the finished bottles, was patented in England by the Toledo Glass Co., of Ohio, on Sept. 15, 1902. The first successful bottle-blowing machine had been invented by the Englishman Ashley in 1888, but this and the many machines that followed had to be supplied with the molten glass by hand, and they were not extensively used.

September 18, 1863.—Nitro-glycerine was first made by Sobrero in 1846, but it was Alfred Nobel who brought it into practical use as an explosive, the first patent—for a mixture of nitro-glycerine and gunpowder—being granted to him in France on Sept. 18, 1863. He started manufacture on a commercial scale in 1862 at Helleneborg, near Stockholm, and not even a disastrous explosion, when his younger brother lost his life and the works were destroyed, discouraged him from continuing his researches. The danger in handling the new explosive, which greatly restricted its use for some time, was removed by Nobel's invention of dynamite (see Calendar of Patent Records, July 8).

September 20, 1849.—An early instance of electro-metallurgy is supplied by the patent granted to W. E. Staite and William Petrie on Sept. 20, 1849, for various improvements in the construction and use of the electric battery. A process for fusing iridium is described, in which are employed a bed of iridium powder about ½ in. thick, supported on a copper slab connected to the positive terminal of a battery, and a solid iridium electrode connected to the other terminal. The electrode is brought gently into contact with the top of the powder and immediately withdrawn about ⅛ in., and then moved horizontally to and fro along the top of the powder, whilst the arc plays between it and the powder.

Societies and Academies.

LONDON.

Institute of Metals (Annual Autumn Meeting at Düsseldorf), Sept. 9.—**A. G. C. Gwyer** (Autumn Lecture): Aluminium and its alloys (in German). A short account was given of recent work to improve the general reliability of aluminium and its alloys, more particularly from the points of view of soundness and resistance to corrosion. The constitution of the alloys, and of the metal itself, was discussed. Heat treatment of aluminium alloys also received attention. The lecture concluded with a short account of the application of the methods of X-ray spectrography to aluminium.

Sept. 10.—**Walter Rosenhain**: Some methods of research in physical metallurgy. A description of methods developed in recent years, and particularly in the Metallurgy Department of the National Physical Laboratory, especially in connexion with the determination of equilibrium diagrams. A brief account is given of a novel form of electrical dilatometer, making use of measurements of the capacity of a small condenser which is varied by the dilatation of the specimen. In optical pyrometry, a novel method of securing black body conditions, by sighting upon the interior of a gas bubble blown in a mass of molten metal, is described. In work on structure it is necessary to secure a high degree of purity of the metal and special refractories have been developed.—**G. Masing**: Methods of research in metallography. Researches on the constitution of alloys must be based on the well-established thermodynamical laws of heterogeneous equilibria. The experimental methods need to be improved in precision and amplified (especially X-ray technique). The most important improvement required is the development of a method for the rapid attainment of equilibrium in an alloy. The study of constitution also demands an investigation of the condition of alloys far removed from the state of equilibrium; theoretical and experimental aspects of this problem are considered.—**P. Chevenard, Portevin, and X. F. Waché**: A dilatometric study of some univariant two-phase reactions. The reactions in quenched aluminium-copper and aluminium-silicon alloys, when annealed at various temperatures. Alloys of iron, nickel, and copper have also been investigated by means of the dilatometer, and the boundary of the two-phase field on the iron side of the system has been determined.—**Mas Haas and Denzo Uno**: An improved differential-dilatometer. The accuracy of Chevenard's optical differential-dilatometer has been improved by mounting the apparatus on a triangular rail, by using one dilatometer tube instead of two, and by replacing the spring that holds the mirror by a magnet coil arrangement. Provision is made for working in any special atmosphere.—**W. H. J. Vernon and L. Whitby**: The open-air corrosion of copper: a chemical study of the surface patina. In general, the green patina consists essentially of basic copper sulphate. An exception is the product from a purely marine atmosphere, in which basic copper chloride predominates; where urban and marine conditions coincide, however, then basic sulphate greatly predominates. Basic copper carbonate enters only to a minor extent into the composition of the product, even in rural districts remote from sea and town. Sulphur compounds, derived from products of combustion and disseminated by wind, are the most potent agents in the development of patina. The underlying metal, after long periods of exposure, shows remarkable freedom from pitting.—**C. O. Bannister**: Studies on the crystallisation of gold from the liquid state. Different methods are given of preventing undercooling and 'flashing'.

Formation of straight boundary lines by the interference of radial growth from two, three, and four nuclei, and the formation of curved boundary lines by retardation of growth from one centre are illustrated.—**A. Glynne Lobley** and **C. L. Betts**: The creep of 80 : 20 nickel-chromium alloy at high temperatures. Wires 0·018 in., 0·0625 in., and 0·25 in. thick were subjected to tensile stresses of 50, 100, 200, and 400 lb. per in.^{2} at temperatures of 700°, 800°, 900° and 1000° C. for a period of approximately 4000 hours. The rate of flow was found to be dependent on the diameter of the wire as well as on other factors.

PARIS.

Academy of Sciences, July 29.—**Charles Moureu, Charles Dufraisse**, and **Paul Gagnon**: Researches in the phenylindene series. The extension of Wolff's reaction to the direct preparation of a hydrindenic hydrocarbon starting from the corresponding ketone.—**Charles Richet** and **Michel Faguet**: The action of sea water in extremely small amounts on fermentation. Sea water in the concentration of 10^{-10} per cent still exerts a definite action on the lactic fermentation.—**Gabriel Bertrand** and **Mlle. Voronca-Spirt**: Titanium in animals. As a result of experiments on twenty species of animals, it is concluded that titanium exists in animals, but in proportions varying with the organ and species. Exceptionally, no titanium could be detected in organs of the rabbit, but a relatively high proportion was found in the hair of this animal.—**Charles Nicolle, Charles Anderson**, and **Jacques Colas-Belcour**: The relations between the recurrent Moroccan spirochæte *Sp. hispanicum var. marocanum* with the porcupine.—**Paul Delens**: The properties of certain families of curves.—**N. Lusin**: The semiregular parametric representation of ensembles.—**P. L. Srivastava**: The singularities of a class of Dirichlet's series.—**Radu Badesco**: An integral equation.—**André Marcelin**: Surface coatings on water and molecular dimensions. The direct determination of the thickness of a film in a state of saturation is frequently impossible on account of the solubility. The author outlines a method for avoiding this difficulty.—**Fahir Emir**: Superficial solutions and molecular films. The study of some substances and the determination of the lengths of their molecules. Data are given for palmitic and stearic acids and for cetyl alcohol. Applying the rule given by A. Marcelin to these data, the lengths of the molecules found agree closely with those determined by X-ray methods.—**Jean Guastalla**: Superficial solutions of oleic acid. Measurement of very low pressures. Development of the methods of André Marcelin, with details of some improvements in detail.—**D. Chalonge** and **Ny Tsi Zé**: The continuous spectrum of the hydrogen atom. Details of the changes in the hydrogen spectrum produced by passing from discharge without a condenser to the condensed discharge. Curves are given showing the changes produced in the intensity of the radiation as a function of the wave-length for four types of discharge.—**J. Loiseleur**: The ballistic effect exercised by thin polished metallic plates.—**Severiano Goig**: The compressibility of carbon monoxide at 0° C. above 50 atmospheres. Details of methods of preparation and purification of the carbon monoxide used are given; an accuracy of 0·02 per cent is claimed for the results. Over the range of pressures obtained in the experiments, the values of pv for carbon monoxide are lower than those for nitrogen. The minimum pv for nitrogen at 0° C. is 72 atmospheres, for carbon monoxide at the same temperature, 90 atmospheres.—**Albert Portevin** and **François Le Chatelier**: High temperature tests on metals and alloys by compression and by wire drawing.—**Arakel Tchakirian**: Basic acetate and basic sulphate of gallium and gallium oxalate. The preparation of the basic gallium salt

$$4Ga(CH_3CO_2)_3 . 2Ga_2O_3 . 5H_2O$$

is described. Aluminium, zinc, indium, and iron do not form basic acetates under similar conditions, and hence the compound serves as a means of separating gallium.—**Joseph Robin**: Researches in the rubrene series. Nitrogen compounds obtained starting with the chloride of diphenyl phenylethinyl carbinol, $(C_6H_5)_2CCl . C \equiv C - C_6H_5$. Study of the products of the reaction of this chloride with ammonia and with aniline.—**Pierre Bedos**: The retrogradation of the C_6 ring into the C_5 ring with the aid of the etherate of magnesium bromide. It is shown that in the reaction between organo-magnesium compounds and cyclohexene oxide or chlorhydrin, the C_6 ring passes into a C_5 ring, with transitory formation of cyclopentane aldehyde.—**Couvreur**: The brechoid chalk of Plaisir (Seine-et-Oise).—**Henri Termier**: The Devonian of Tafilalet.—**Alfred Carpentier**: The fructifications of *Rhodea Gutbieri*.—**D. Chouchak**: The struggle between cultivated plants and the soil micro-organisms for their mineral nutrition: the action of dried blood on phosphate manure.—**J. Régnier**: Measurements of the activity of cocaine hydrochloride on different nerve trunks.—**Ernst A. H. Friedheim**: Concerning the oxidation-reduction potential of the tissues of mammals.

CAPE TOWN.

Royal Society of South Africa, July 17.—**John P. Dalton**: On integrating factors and Jacobi's equation. The author's method of the 'common integrating factor' is applied to Jacobi's equation, and the general solution is thereby obtained. By means of the linear integrals and what are called parallel loci, the relations of the integral curves to the singularities are discussed for all types of root of the characteristic cubic.—**E. N. Grindley**: A new method of observing diurnal variation of magnetic intensity and declination, using field instruments. The principal sources of error in the 'deflection' method of obtaining diurnal variation curves are eliminated or considerably reduced by using the method of timing vibrations of the long magnet of an ordinary magneto-meter. A routine was described by which H and D can be simultaneously measured (and the results computed) in less than twenty minutes, the accuracy being estimated at 5 gamma units.

Official Publications Received.

BRITISH.

The Indian Forest Records. Economy Series, Vol. 14, Part 1: The Burma Bamboo Pulp Survey. By W. Raitt. Pp. 8+48+9 plates. (Calcutta: Government of India Central Publication Branch.) 2.10 rupees; 4*s*. 9*d*.

Memoirs of the Queensland Museum. Edited by Heber A. Longman. Vol. 9, Part 3. Pp. iv+207-363+plates 27-35. (Brisbane.)

Empire Marketing Board. Note on the Work and Finance of the Board and Statement of Research and other Grants approved of by the Secretary of State for Dominion Affairs from July 1926 to March 31st, 1929. (Cmd. 3372.) Pp. 31. (London: H.M. Stationery Office.) 9*d*. net.

University of Birmingham: Executive Board of Mining Research. Report on the Work of the Mining Research Laboratory during the Year 1928. Pp. 13. (Birmingham.)

Board of Control (England and Wales). General Paralysis and its Treatment by Induced Malaria. By Surgeon Rear-Admiral E. T. Meagher. Pp. 88. (London: H.M. Stationery Office.) 2*s*. net.

Union of South Africa: Fisheries and Marine Biological Survey. Report No. 6 for the Year ending June 1928; and Special Reports. By Dr. Ceal von Bonde. Pp. 71+36+7+5+21+11+11 plates. (Pretoria: Government Printing and Stationery Office.)

Records of the Botanical Survey of India. Vol. 12, No. 11: The Forests of Kalimpong; an Ecological Account. By Dr. J. M. Cowan. Pp. ii+74+2 plates. (Calcutta: Government of India Central Publication Branch.) 3.8 rupees; 6*s*.

Trinidad and Tobago. Council Paper No. 52 of 1929: Administration Report of the Conservator of Forests for the Year 1928. Pp. 20+2 plates. (Trinidad, B.W.I.: Government Printer, Port-of-Spain.) 8*d*.

The Hundred and Seventh Report of the Commissioners of Crown Lands. Pp. 35. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Mines Department. Publications of the Safety in Mines Research Board, Vol. 3, 1927: Reports and Papers relating to Research into Coal Dust, Firedamp and other Sources of Danger in Coal Mines. Pp. 11. (London: H.M. Stationery Office.) 2*d*. net.

Department of Public Instruction: Technological Education Branch, New South Wales. Technological Museum: Curator's Annual Report for Year ended 31st December 1928. Pp. 5. (Sydney, N.S.W.)

Department of Agriculture: New South Wales. Science Bulletin No. 33: Veterinary Research Report No. 4. By Dr. H. R. Seddon. Pp. 106. (Sydney, N.S.W.: Alfred James Kent.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 42: A Soil Survey of Block E (Renmark) and Ral Ral (Chaffey) Irrigation Areas. By J. K. Taylor and H. N. England. Pp. 51+1 plate. (Melbourne: H. J. Green.)

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 2 (New Series), No. 7, July 1929. Abstracts Nos. 1280-1560. Pp. v+249-285. (London: H.M. Stationery Office.) 9*d*. net.

Bulletin of the Madras Government Museum. New Series, Natural History Section, Vol. 2: The Flowering Plants of Madras City and its Immediate Neighbourhood. By P. V. Mayuranathan. Pp. 345+38 plates. (Madras: Government Press.) 8 rupees.

Journal and Proceedings of the Asiatic Society of Bengal. New Series, Vol. 24, No. 1. Pp. 175+8 plates. New Series, Vol. 24, No. 2. Pp. 165. (Calcutta.)

Mysore Geological Department. Bulletin No. 10: Report on the Copper Ore Deposits of Ingaladhal, near Chitaldrug. By A. M. Sen and B. Rama Rao. Pp. v+15+3 plates. (Bangalore: Government Press.) 1 rupee.

Indian Lac Association for Research. Reports of the Committee and of the Director, Indian Lac Research Institute, Nankum, Ranchi, for the Year 1st April 1928 to 31st March 1929. Pp. ii+32. (Calcutta.)

Union of South Africa: Department of Agriculture. Bulletin No. 51: Further Citrus Canker Studies. By E. M. Doidge. Pp. 31. (Pretoria: Government Printer.) 3*d*.

Annals of the South African Museum. Vol. 27: The Stone Age Cultures of South Africa. By A. J. H. Goodwin and C. Van Riet Lowe. Pp. ix+289+45 plates. (Cape Town.) 25*s*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1223 (Ae. 378): On the Two-Dimensional Flow past a Body of Symmetrical Cross-section mounted in a Channel of Finite Breadth. By A. Fage. (T. 2720.) Pp. 12+5 plates. 9*d*. net. No. 1232 (Ae. 387): On the Maximum Load in Pulling out from Vertical Dives. By S. B. Gates and H. B. Howard. (T. 2722.) Pp. 9+2 plates. 9*d*. net. No. 1240 (Ae. 395): Rolling and Sideslip Experiments on a Model Slotted Biplane of R.A.F. 31 Section. By H. B. Irving, A. S. Bateson and A. L. Maidens. (T. 2737.) Pp. 5+14 plates. 6*d*. net. (London: H.M. Stationery Office.)

Proceedings of the South-Western Naturalists' Union. Edited by Dr. F. S. Wallis. Vol. 2, Part 2, August. Pp. 21-48. (Bristol.)

The Cordwainers Technical College, Eagle Court, St. John's Lane, London, E.C.1. Prospectus of Classes in Boot and Shoe Manufacture and Making, and Leather Goods Manufacture. Day and Evening Classes, Session 1929-1930. Pp. 42. (London.)

FOREIGN.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 597-B: A Study of Ground Water in the Pomperaug Basin, Connecticut, with Special Reference to Intake and Discharge. By Oscar Edward Meinzer and Norah Dowell Stearns. (Contributions to the Hydrology of the United States, 1928.) Pp. iv+73-146+plates 11-19. 35 cents. Water-Supply Paper 597-D: Geology and Water Resources of the Upper McKenzie Valley, Oregon. By Harold T. Stearns. (Contributions to the Hydrology of the United States, 1928.) Pp. ii+171-188+plates 21-23. Water-Supply Paper 636-A: Quality of Water of the Colorado River in 1926-1928. By C. S. Howard. (Contributions to the Hydrology of the United States, 1929.) Pp. ii+14. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Professional Paper 154-F: Water-Laid Volcanic Rocks of Early Upper Cretaceous Age in Southwestern Arkansas, Southeastern Oklahoma and Northeastern Texas. By Clarence S. Ross, Hugh D. Miser and Lloyd W. Stephenson. (Shorter Contributions to General Geology, 1928.) Pp. iv+175-202+plates 18-27. 25 cents. Professional Paper 154-G: Algae Reefs and Oolites of the Green River Formation. By Wilmot H. Bradley. (Shorter Contributions to General Geology, 1928.) Pp. ii+203-223+plates 28-48. Professional Paper 154-H: A Revision of the Flora of the Latah Formation. By Edward Wilber Berry. (Shorter Contributions to General Geology, 1928.) Pp. ii+225-265+plates 49-64. 30 cents. Professional Paper 154-I: *Exogyra olisiponensis* Sharpe and *Exogyra costata* Say in the Cretaceous of the Western Interior. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1928.) Pp. ii+267-278+plates 65-69. 10 cents. Professional Paper 154-J: Additions to the Flora of the Green River Formation. By Roland W. Brown. (Shorter Contributions to General Geology, 1928.) Pp. ii+279-299+plates 70-76. 20 cents. Professional Paper 157: The Mother Lode System of California. By Adolph Knopf. Pp. viii+88+12 plates. 55 cents. (Washington, D.C.: Government Printing Office.)

Field Museum of Natural History. Geological Series, Vol. 4, No. 5: Contributions to Paleontology. By Sharat Kumar Roy. (Publication 254.) Pp. 199-220+plates 32-40. Zoological Series, Vol. 12, No. 18: A Contribution to the Ornithology of Northeastern Brazil. By Charles E. Hellmayr. (Publication 255.) Pp. 233-501+plate 22. Report Series, Vol. 7, No. 3: Annual Report of the Director to the Board of Trustees for the Year 1928. (Publication 256.) Pp. 377-600+plates 42-61. Zoological Series, Vol. 17, No. 1: The Birds of the Neotropical Genus Deconychura. By John T. Zimmer. (Publication 257.) Pp. 18. (Chicago.)

Department of the Interior: Bureau of Education. Bulletin, 1929, No. 7: Accredited Higher Institutions, 1927-1928. By Ella B. Ratcliffe. Pp. v+56. (Washington, D.C.: Government Printing Office.) 10 cents.

Methods and Problems of Medical Education. (Thirteenth Series.) Pp. 130. (New York City: The Rockefeller Foundation.)

Anales del Museo Nacional de Historia Natural Bernardino Rivadavia. Tomo 34. Pp. x+601. (Buenos Aires.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 28, Part 1: The North American Species of Paspalum. By Agnes Chase. Pp. xviii+310. (Washington, D.C.: Government Printing Office.) 70 cents.

CATALOGUES.

X-Ray News and Clinical Photography. Vol. 1, No. 7, June. Pp. 81-92. (London: Kodak, Ltd.)

Fluorescence Analysis. The Instant Test of Raw Materials for Grade and Genuineness: The Proof of Validity for Cheques, Notes and Securities, Paintings, Rare Stamps, etc. Pp. 20. (London and Slough: The British Hanovia Quartz Lamp Co., Ltd.)

Man through the Ages: his Origin, Customs and Beliefs; a Catalogue of Books on Anthropology, Folklore and Early Civilizations, including Ethnography, Mythology, Magic, Totemism, Witchcraft, etc. (No. 517.) Pp. 76. (London: Francis Edwards, Ltd.)

New Instruments of Great Rapidity for Measuring Radiation, designed by Moll and Burger. (VLU. 29.) Pp. 4. The Moll Micro Galvanometer. (Migalv. 29.) Pp. 2. Zernike Thermopile. (Gezu. 29.) Pp. 2. The Moll Recording Microphotometer. (MF. 29.) Pp. 11. (Delft: P. J. Kipp en Zonen.)

Diary of Societies.

TUESDAY, SEPTEMBER 17.

IRON AND STEEL INSTITUTE (in Secondary Schools, Doncaster Road, Scunthorpe), at 6.30.—Discussion on following papers: Notes on the Damping-down and Re-starting of Blast-Furnaces, C. S. Gill; High Elastic Limit Structural Steels, J. A. Jones; The Hardness of Vacuum-Annealed Crystals of Iron, H. O'Neill.

WEDNESDAY, SEPTEMBER 18.

CERAMIC SOCIETY (Refractory Materials Section) (at Midland Grand Hotel, St. Pancras), at 10 A.M.—G. Lavelle: Drying Clay Goods.—H. Pardoe: Hot Patching.—J. M. Coon: Micro-structure of Silica Building Bricks.—Dr. G. Martin: Thermal Inefficiency of Rotary Kiln.—Dr. C. Sykes: Molybdenum Wirewound Furnaces.—(Building Materials Section), at 10 A.M.—G. Lavelle: Drying Clay Goods.—At 10.45.—L. G. Tomlinson: Some Different Methods of Fixing Roofing Tiles and their Influence on Tile Lamination.—J. Procter: Mechanical Stoking of Kilns.—L. F. Cooling: A Contribution to the Study of Fluorescence: The Evaporation of Water from Brick.

THURSDAY, SEPTEMBER 19.

CERAMIC SOCIETY (Refractory Materials Section) (at Midland Grand Hotel, St. Pancras), at 10.15 A.M.—S. R. Hind and F. Wheeler: Effect on Non-plastics on Shrinkage.—G. T. Harley: Scientific Shovelling.—F. West: Notes on American Trip.—(Building Materials Section), at 10 A.M.—E. Simpson: The Value of a Laboratory to a Clayworks Manager.—I. Lubbock: Oil Fuel and the Brick Industry.—Facing Bricks, Road Paving Bricks, and Roof Tiles, as Manufactured in the State of Ohio, U.S.A.—At 11.30.—F. West: Notes on American Trip.

CONFERENCES.

SEPTEMBER 16 AND 17.

BIBLIOGRAPHIQUE INTERNATIONALE (at Imperial College of Science).

Monday, September 16.—Council Meetings.

Tuesday, September 17, at 10 A.M.—Prof. A. F. C. Pollard: Presidential Address.

The agenda will include Further Proposals for the Reorganisation of the Institute, Reports of the Commissions on Cataloguing Rules and on Documentary Technique, and a Discussion on the Possible Unification of the Aims and Objects of International Bibliographical Organisations.

SEPTEMBER 20–23.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Trinity College, Cambridge).

Friday, September 20, at 6.45.—Reception of Delegates by the Council of the Association.

At 7.15.—Dinner. Address by Sir J. J. Thomson, the President-elect.

At 8.30.—Brig.-Gen. M. Mowat: The Year's Work of the Association.—Laurie Magnus: The Approach of the Producer to the Consumer of Information.

Saturday, September 21, at 10 A.M.—S. H. Hamer: The Preservation of Places of Natural Beauty and Historic Interest.—A. Parker: Duplicating Machinery: A Survey of Modern Methods.—E. J. MacGillivray: Duplication, and Infringement of Copyright.—Dr. W. Bonser: The Ideal Form of a Journal from the Librarian's Point of View.

At 5.30.—Annual General Meeting.

At 8.30.—G. T. Hankin: Books versus Text-books, the Problem of the Schools.—R. A. Austen-Leigh: Organised Information in the Printing Trade.—E. W. Ashcroft: Technical English.—E. Green: The Information Service of a Public Library.—P. A. Green: The Information Service of a Bank.

Sunday, September 22, at 10 A.M.—A. F. Ridley: The Training of Special Librarians.—H. Rottenburg: Indexing and Classifying of Individual Collections of Data.—A. P. L. Gordon: Sources and Application of Business Data.—E. T. Elbourne and H. G. T. Cannons: An Indexing System for Published Business Information.

At 8.30.—P. Otlet: International Organisation of Information Services.